THE IMPACT OF CHILD SURVIVAL INTERVENTIONS IN INDONESIA

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ASSESSING THE IMPACT OF CHILD SURVIVAL INTERVENTIONS IN INDONESIA: A NEW INDEX OF HEALTH STATUS

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Abstract

Health program evaluations typically are concerned with either mortality or nutritional status as an outcome variable. Health interventions can affect both child survival and nutritional status, therefore an impact evaluation should consider both outcomes. If these are to be considered simultaneously, the question is how to combine counts of dead with observations on the living children into a unified index of health status of a population, since the use of either mortality or nutritional status alone may give a misleading result. The purposes of the present study are as follows: first, to determine minimum indicator(s) that can be used to describe the impact of child survival interventions using survey data; second, to assess the relative contribution of child survival interventions and other competing factors affecting health.

In 1988, we conducted a cluster survey that used a complex design and interviewed 8054 out of 184,129 households from Timor, Indonesia. A total of 22,440 births were reported to occur among 5,974 married women aged 15 to 49 years. Out of children ever born, 5,292 were born during the last five years, and of these, 282 children were reported to have died. Only 4715 of these children are finally used for the assessment of the index of health status. These had data on nutritional status (anthropometry), child survival interventions (i.e., growth monitoring, oral rehydration therapy, immunization status, antenatal care, and contraceptive use), and socioeconomic factors (i.e., maternal education, father's occupation, availability of latrine, and total family income) are available.

For all athropometric measurements, we consider under–5 children with a NCHS/CDC's Z–score equal to or above -1 as a grade 0 (normal), below -1 to -2 as a grade I, -2 to -3 as a grade II, and -3 as a grade III of growth faltering. Our index of health status includes these four grades for surviving children, while a child death is assigned a grade IV, so that the index of health status is an ordinal scale variable with 5 possible values. An indirect estimation method is used to present mortality determinants at the aggregate level, while a proportional hazard model for grouped data is used to examine determinants of child survival at the individual level. A generalized linear model for ordinal data (proportional odds) is used to analyze nutritional and health status determinants.

Although the mortality level is still high, there is an obvious trend towards mortality decline in the study area. This decline can be attributed to adoption of child survival interventions, specifically growth monitoring, immunization, family planning programs, but cannot be linked with oral rehydration therapy and antenatal care programs. More than half of under–5 years old children are underweight or stunted, and about 16 percent are wasted. Child survival interventions show no independent effect on the probability of becoming underweight, stunted, and wasted. The impact of child survival interventions on health status appears to arise primarily from the protection of children from death. At the same time, socioeconomic factors affect child health status primarily through the reduction of growth faltering. In contrast with the impact of child survival interventions on mortality, socioeconomic factors did not affect nutritional status through the utilization of growth monitoring, oral rehydration therapy, immunization, and family planning programs. Data show strong evidence that the determinants of mortality do not necessarily act as determinants of nutritional status.

Among the three indices of health status created (based on weight–for–age, height–for–age, and height–for–age) the index that involves weight–for–age is considered the best indicator. This study shows that ordinary least squares can be used for the assessment of determinants of health status, but only when weight–for–age data is used.

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Chapter 1

INTRODUCTION

1.1 PROBLEM

In the context of quantitative assessments of primary health care programs, many methodological questions remain to be answered about how the impact of these programs should be estimated at the population level (*Hansluwka, 1985; Graham, 1989*). Of more concern, only knowing the magnitude of a program's impact after an intervention is not sufficient, since understanding the specific mechanisms by which intervention can operate is very important to policy makers (*Ruzicka, 1989; Mosley, 1985*). In child survival interventions, the issue is complex due to the fact that the level of child survival is strongly determined by both bio–demographic characteristics (*birth order, maternal age, birth spacing, breast feeding, and nutrient intake*) and a broad set of socioeconomic variables (*parental education, paternal occupation, dwelling characteristics, place of residence*). It is now recognized that health interventions are only one of a set of factors contributing to child survival (*Mosley and Chen, 1984*). Nevertheless, the ultimate aim of health projects is to achieve a health impact, defined as reduction in mortality, morbidity, and improved nutritional status (*Van Noreen, Boerma, and Sempebwa, 1989*).

Health program evaluations typically concern either mortality or nutritional status as an outcome variable. On one hand, demographic studies commonly use survival status (*dead or alive*) as an indicator of success or failure of health intervention and disregard the health status of survivors. On the other hand, many evaluation studies only examine the health status of survivors and do not use information on dead children. Typically, health status of children is measured from weight–for–age, height–for–age, and weight–for–height which are converted to nutritional status levels (*i.e., following the Gomez's classification categories 0, I, II, and III*). Because health interventions can affect both child survival and nutritional status, health program evaluations should consider both survival and nutritional status of children as outcome variables (*Mosley, 1984*).

A conceptual framework for the study of child survival which included measuring nutritional status combined with mortality data as an outcome variable (*"index of health status"*) was proposed Mosley and Chen (*1984*). They suggested using a Gomez's classification (*Gomez et al., 1956*) which includes four grades of nutritional status (0, I, II, and III) and assigning a child death at grade IV as an outcome variable. The framework explains the level of child survival by integrating biological and social factors that operate at the community (*macro level*) and household or individual level (*micro level*). Within this framework, all health programs, as well as social, economic and regional characteristics, should affect children through five groups of intermediate variables: maternal factors, environmental conditions, nutritional factors, personal illness control, and injuries. Using this framework, one may include provider or program characteristics as a set of health system variables acting at the macro level.

Up to now, the use of "index of health status" as an outcome variable has not been reported from the less developed countries (*LDCs*), including Indonesia. In addition to the problem of availability of complete data to test this framework, the statistical estimation seems to be an obstacle when provider and program effects are included in the model simultaneously with mother's and child's characteristics. More importantly, the method of combining mortality and nutritional status into a single indicator requires empirical evidence from a single–round household survey.

Despite the existence of methodological problems, it is essential for policy makers to understand both the health impact as well as the operation of interventions. Both the impact and the operation of the interventions are likely to be influenced by the distribution of biodemographic and socioeconomic factors. The magnitude of impact can be evaluated at the macro level using an ecological approach (*Morgenstern, 1982*); however, to understand the operations of the interventions (*causation*), one must examine the behavior of individual women within their community setting (*Greenland and Morgenstern, 1989; Richardson, Stucker, and Hemon, 1987*). Failure to recognize the difference in mechanisms by which interventions operate in different populations can result in ineffective or inefficient intervention programs (*Faechem, Wendy, and Timaeus, 1989*).

Many studies suggest that community characteristics determine the acceptability of health interventions, such as immunization programs (*Streatfield and Singarimbun, 1988*), weighing programs (*Achadi, 1990*) and contraceptive distribution (*Warwick, 1986*). It is clear that response to an intervention can depend upon specific program characteristics, factors related to the targeted population, and other aspects of the social environment.

1.2 THE STUDY OBJECTIVES AND HYPOTHESES

This thesis has two fundamental objectives:

1. to determine the minimum indicator(*s*) that can be used to describe the impact of a health intervention program using survey data. Is a single number such as "index of health status", which combines nutritional status and child mortality, a sufficient summary of the impact of a child survival intervention? A sufficient summary is meant in terms of capturing average effects of determinants on mortality and nutritional status.

2. to assess the relative contribution of health program interventions and other competing factors affecting health at the regional level. That is, to estimate the proportion of variation in "index of health status" attributable to the differential impact of interventions, after taking into consideration the regional and other background characteristics outside the program at the micro and macro levels.

Our study will focus on the relationships between the use of several standard child survival interventions (*i.e., growth monitoring, oral rehydration therapy (*ORT*), breast–feeding promotion, and immunization or so called GOBI*) and the "index of health status" in Indonesia. In order to answer these objectives, the following hypotheses are tested:

1. Under equivalent geographic and demographic characteristics of the population, a parsimonious model of the association between

child survival interventions and mortality will have different covariates from those of a parsimonious model of the association between child survival intervention and nutritional status of the children.

2. The use of an "index of health status" as an outcome variable will have a better value for assessing the population impact of child survival interventions of either nutritional status or mortality alone as the outcome.

The details and theoretical bases of these hypotheses will be discussed along with the analytical framework in the next chapters. It should be noted that this study will be limited to the use of survey data, although this may not be the ideal method of assessing the impact of an intervention. However because of the complexity of the issues and the fact that we are almost certain about the biological efficacy of the specific child survival interventions discussed, this analysis may be narrowed to the measuring of effectiveness of the intervention in terms of improving child survival in the population. Certainly because health surveys are conducted routinely in many countries, the understanding how to use this survey data optimally is another important motivation for this study.

To test our hypothesis number 1, the following steps numbers 1 and 2 will be performed. The following step number 3 is addressed to the hypothesis number 2.

1. "Parsimonious" models of the association between child survival interventions and mortality will be identified without considering the issue of hierarchial linear models. This approach implies that when there are several models where the goodness of values of ex-

planatory variables of models (*i.e., values of maximum likelihood*) are about the same level, we would choose the one with the smallest number of explanatory variables. In this step, two models of child mortality determinants will be examined: a) using information on the number of children dead among children ever born to women married less than 15 years and b) the survival status of the children born within the last 5 years.

2. "Parsimonious" models on the association between child survival intervention and nutritional status, using the same framework which uses mortality as an outcome will be established.

3. An analytical method using a generalized linear model for ordinal data will be proposed, which seems to be appropriate in dealing with outcomes that combine both nutritional status and mortality. Using this approach, we will determine whether child survival interventions can be associated with the newly defined "index of health status". The factors associated with this index will then be compared with both mortality and nutritional status determinants.

1.3 RATIONALE

1.3.1 Measurement Problems

Over the last few years efforts have been made to refine measurement methodologies to assess the impact of population–based health intervention programs. A distinction should be made between "impact", which represents the combined outcome of health programs, and "effect" which may be attributed to a specific intervention (*Graham, 1989*). For example, the effects of a training program for health cadres on the use of oral rehydration therapy may be seen in a fall in the number of deaths due to diarrheal diseases, whereas the impact of delivering of basics health services through health cadres may be detected in a decline of the child mortality rate.

Recently, achieving a mortality impact has become the primary goal of health programs, and the success of a program is almost synonymous with mortality reduction. Such “body counts” are, however, considered by some authors as neither a sufficient basis for planning health services nor for the assessment of the health effectiveness of an intervention (*Habicht and Berman, 1980*). Despite this criticism, mortality impact is measured for two main reasons: there is a concern with the internal achievements (*effectiveness*) of a specific programs, and there is a concern with its achievements relative to other programs, particularly in terms of resources expended (*Faruqee, 1982*). For those who are concerned with a specific program, the interest lies in the determination of the size of the impacts and the test of the strength of the association between inputs and impacts. For those concerned with making comparisons between different programs, the cost justification in terms of number of deaths prevented will be their main interest (*D'Souza, 1989*).

The use of morbidity data as an indicator of the health impact of an intervention is less frequent due to many methodological problems. The major problems are the difficulties in diagnosing the disease in population surveys, seasonality of disease incidence, sporadic occurrence of epidemics, and problems in quantifying severity and duration of illness. Although morbidity has been used for a setting of health program priorities (*Ghana Health Assessment Project Team 1981*), the application in population surveys will be hampered with such methodological problems. Little is known therefore about the sensitivity and specificity of disease incidence as an indicator of health impact, even with narrow intervention programs where "selective primary health care" (*Walsh and Warren, 1979*) has been implemented (*Hansluwka, 1985; Van–Noreen, Boerma, and Sempebwa, 1989*). For these reasons, impact evaluation related to morbidity in children may be shifted to the ultimate consequences of morbidity, either growth faltering or mortality, which have less measurement problems (*Mosley and Chen, 1984*).

Measurement of nutritional status has been suggested as a potentially useful indicator of the health and welfare of communities (*Dowler et al., 1982*), as well as an indicator of the consequences of health interventions. The use of several anthropometric indicators for health program evaluation has been reviewed by Habicht and Butz (*1979*). They concluded that both height and weight of children are sensitive to health interventions.

In studying child survival in LDCs, information on the nutritional status and mortality may be combined as an "index of health status" (*Mosley and Chen, 1984*). Essentially, although using a cross–sectional survey this index will be able to embrace information on the past experiences and future risks of the population simultaneously. The reasons are as follows:

1. growth faltering is known as an indicator of the current health status of the population, and it can be used as a measure of the relative risk of various subgroups of that population to mortality in the future (*Bairagi, 1981; 1985; Briend, Wojtyniak, and Rowland, 1987; Chen, Chowdhury, and Huffman, 1980; Heywood, 1982; The Kasongo Project Team, 1983; 1986; Katz et al., 1989;*

Kielman, and McCord, 1978; Trowbridge and Sommer, 1981.);

2. growth faltering is also sensitive to the availability of medical services and the prevalence of certain diseases (*Habicht and Butz, 1979; The Kasongo Project Team, 1983*); and

3. mortality is included in the index of health status since it reflects past cumulative exposure to morbidity experiences (*Martorell, et al, 1975, Mata, Urrutia, Lechtig, 1971; Mata, et al., 1972*).

From a methodological standpoint, the "index of health status" has an advantage since the burden of requiring a large sample size in a mortality study can be reduced by using an outcome variable that has a relatively high frequency in the community.

1.3.2 Determinants of Child Survival and Health Interventions

There is general recognition of the importance of socioeconomic status in determining child survival in developing societies, including Indonesia (*Hull and Gubhaju, 1986*). Much less is known, however, about the specific impact of heath providers and community health programs in determining child survival under a diversity of socioeconomic levels. It is sometimes assumed that a major improvement in child survival can be achieved with extensive availability of a few relatively inexpensive technologies (*i.e., GOBI*), even in the absence of more substantive socioeconomic changes (*Caldwell, 1986*). However, data from the FASDES 1978 survey in Indonesia strongly suggested that low household income is a barrier to the utilization of modern health services (*i.e., antenatal care, delivery services, and sickness treatment*), even where they are publicly provided (*Chernichovsky and

Meesook, 1986). The data showed the relatively well–to–do spend more money on and are using more heavily the services of trained practitioners and physicians. Similar findings were found in other countries as well (*Benyoussef and Wessen, 1974*).

While there is general awareness that child survival depends upon social and economic factors as well as on community health services, most LDCs are focusing their limited resources toward the "technological approach" (*Mosley, 1986*). The primary emphasis of this approach is reaching entire populations with a few basic technologies. This "outreach" approach is commonly selected by policy makers since only a small fraction of the population has knowledge about and access to modern health services; this extends even to such basic child survival interventions as immunization. The implementation of a top–down program that follows a strict plan of action (*such as the INPRES project in Indonesia*) is considered most practical from a managerial perspective (*Mosley, 1986*). Because there is a heterogeneity among regions in terms of child health and socioeconomic status, the effectiveness of a top–down program can vary from region to region. Accordingly we may have to select child survival intervention programs taking into account the given characteristics of a region. Unfortunately this selection is not easy since the health intervention itself can deviate from the original plan and its delivery can vary according to region. There is also a strong indication that a local community organization (*i.e., women's clubs*) can influence the success of intervention programs at a grassroots level (*Government of Indonesia–UNICEF, 1989, Warwick, 1986*).

Following the Mosley and Chen thesis (*1984*), where the child health status is constrained by both biological and social factors, the community effectiveness of a top–down child survival intervention program must be associated with social and behavioral changes as well as technological interventions. In this context, the utilization of either mortality or child nutritional status alone as a measure of child health status is perceived to be inadequate (*Mosley and Chen, 1984*), especially for monitoring and evaluating the progress of the implementation of the child survival program or strategy. There is a need to include information both from children who have died and who are still alive in evaluating such health programs. To undertake this quantitative assessment, we require a methodological approach which on the one hand combines information on nutritional status with mortality data as outcomes, and on the other hand consider the hierarchial effects of individual and community factors (*a multilevel approach*).

1.3.3 Relevance for the Country–specific Problem

Health levels in Indonesia are still relatively low, although they have improved considerably since the beginning of the independence era after 1945 (*Nitisastro, 1970*). The improvement is, in part, through the government's continued efforts to ensure health services to wider segments of the population by delivering more extensive and accessible medical technology. By the year 2000, the infant mortality rate (*IMR*) is expected to decline from 110 per 1,000 births in 1980 to 46.4 per 1,000 births; the mortality rate for children under age 5 is expected to decline from 40 per 1,000 to 15 per 1,000; and the life expectancy at birth is expected to reach 60 years (*Ministry of Health Republic of Indonesia, 1983*). Thus studies of determinants of infant and childhood mortality are of major concern to policy planners.

Despite this projected decline in mortality, two major problems have recently been recognized as important issues: first, the decline of mortality varies substantially between regions and islands, as well as by socioeconomic status; second, the rate of decline in mortality may not be maintained, as has been demonstrated in other less developed countries (*Gwatkin, 1980*). Currently deaths among children before their fifth birthday account for almost half of all deaths in Indonesia. One–third of all deaths are to infants less than one year old (*Government of Indonesia–UNICEF, 1989*). The numbers indicate that no further decline in the overall mortality rate will be possible without a fall in infant and child mortality.

While improvement in the health status of all Indonesians has been the primary objective of health systems, special emphasis has been given to main problems and needs of children and their mothers (*Government of Indonesia–UNICEF, 1989; Ministry of Health of Republic of Indonesia, 1983*). Four community health programs of particular importance are active in Indonesia:

1. The expanded program of immunization for neonatal tetanus, measles, pertussis, diphtheria, polio, and tuberculosis;

2. The maternal and child health program, which places particular emphasis on improving traditional birth attendant's skills, distribution of vitamin A and iron supplements to pregnant and lactating women, and oral rehydration salts for children;

3. The Village Community Health Development Program, which was designed specifically to better meet the health needs of the rural poor; and

4. The school health program, which was initiated as the main channel for reaching school children with basic messages on health

and hygiene, and to influencing on their health status as well as their attitudes toward health.

5. The breast–feeding promotion and home–based delivery of family planning programs, which may be viewed as efforts to prolong birth spacing.

The Indonesian Government's most direct and intensive efforts to improve nutritional status of the population have been through the Family Nutrition Improvement Program or UPGK (*Government of Indonesia–UNICEF, 1989*). This is an integrated, multi–faceted program of nutritional promotion and education which attempts to treat and prevent mainly protein–energy malnutrition (*PEM*), and iron and vitamin A deficiency. This program is targeted primarily at children under 5 and pregnant and lactating women. The main activity of UPGK is child growth monitoring which is conducted by village community health workers (*health cadres*).

Clearly, community health programs in Indonesia focus heavily on the main child survival interventions: growth monitoring, oral rehydration therapy, breast feeding promotion and immunization programs (*GOBI*). In addition to these complex intervention programs, the home–based delivery of family planning has been present for many years in Indonesia (*Suyono, 1989*). It is interesting to see whether these programs can be linked to the current level of child health in Indonesia. Furthermore, there is a very reasonable argument that the child survival programs can improve nutritional status as well as mortality. The question is, can we measure both impacts in the population setting cross–sectionally? So far there has been no large–scale quantitative assessment of child survival interventions able to answer this question, especially looking at the health impact by considering mortality and nutritional status simultaneously.

1.4 SIGNIFICANCE OF THE STUDY

The significance of this study can be viewed from three perspectives: policy, theoretical, and methodological. It has been recognized by policy makers that infant and child mortality levels and the nutritional status of children are indicators of achieving equity in development and improving the welfare of the people. Therefore, a simple index able to summarize both nutritional status and mortality at the regional level is preferred. Such an index will be very useful both for analytical study as well as in a policy formulation and a program implementation. For example, this index can be used to identify the most vulnerable groups of a population, which might appear to have been left behind or lagging in participation, when examining the benefit from health interventions and social development.

Different strategies especially designed to reduce child mortality and improve the nutritional status of children are needed to lessen the differences in child survival between regions and socioeconomic classes and to improve the overall level of health. Identification of effective strategies requires a better understanding of determinants of child survival, and factors responsible for the observed regional and individual variations. The selection of intervention strategies is an important topic for many LDCs, since most of national development policies have placed an emphasis on issues of equity in the population but also find themselves restricted by a limited budget for health interventions.

From a standpoint of theory, identifying the specific mechanisms that link socioeconomic factors with proximate determinants of child health could lead to a better understanding of the role of proximate determinants, especially health interventions as causes of variation at both the regional and individual levels. For example, does an increase in the number of government health service facilities act as a main determinant for the utilization of child survival intervention, or is such utilization mainly determined by the characteristics of each individual family, such as education and income? If it is not possible to explain any of the past mortality trends and current differentials on the basis of past government health intervention alone, then it would be inappropriate to draw the conclusion that similar health interventions that disregard of socioeconomic factors can make a difference in health status in the future (*Ruzicka, 1989; Mosley, 1985b*). This component of the study will improve our understanding of the determinants of child survival and relationships of these determinants with health interventions and socioeconomic developments.

The final aspect of this study is a methodological one. It deals with two questions: 1) What statistical techniques can be used to evaluate two outcomes simultaneously, such as mortality and nutritional status? 2) How should we deal with the issues of hierarchial data when our interest is in assessing effects of macro and micro variables in the same model (*namely household and community variables*)? With the availability of current statistical methods and software this study will specifically address these issues.

1.5 ORGANIZATION OF THE THESIS

In chapter 2, a review of literatures is presented. The review focuses on substantive issues that lead to the statement of hypotheses that will be tested. The conceptual framework and statistical approach related to our hypothesis are described in chapter three. Chapter four discusses sources of the data, survey instruments, data gathering process, and definitions of variables considered in the analysis. Chapter five begins with a brief description of Indonesia followed by the descriptive figures of study population according to our survey results. Chapter six is devoted to the assessment of determinants of child mortality and seeks to obtain a parsimonious model to test our hypotheses. Chapter seven examines the determinants of nutritional status both at the aggregate and individual levels. Chapter eight is devoted to the analysis of "the index of health status". The results are compared with the results found in chapters six and seven. Finally, chapter nine is a discussion of the results with some conclusions and recommendations for further research.

Chapter 2

LITERATURE REVIEW

2.1 INTRODUCTION

In this chapter, an overview of the major theoretical bases for the direct or indirect association between child survival interventions and mortality or nutritional status of the children will be presented. Following the Mosley and Chen (*1984*) proximate determinants framework, we will consider both mortality and nutritional status as outcomes associated with child survival interventions. It is assumed that all of health interventions, as well as socioeconomic factors, affect child health through the proximate determinants.

Following a brief discussion of child survival intervention in the Less Developed Countries (*LDCs*), empirical studies of association between health interventions and mortality or nutritional status of children under 5 years old will be reviewed. This chapter focuses on two questions:

1. What is the impact of child survival interventions on improving the life conditions of children in LDCs, and how is this impact measured?

2. What are the mechanisms by which the interventions yield an

improvement in health status.

The aims of this review are to lay the foundation for our research on: how child survival interventions improve child health, and why impact measures should consider both mortality and nutritional status.

2.2 IMPACTS OF CHILD SURVIVAL INTERVENTIONS

In the 1980s, the debate on developments in the field of health and medical care revolved around two central issues (*Rifkin and Walt, 1986; Warren, 1988*). The first issue dealt with how new technologies can be introduced, accepted, supported, and maintained within communities by cultures which have little scientific knowledge about "a Western medical paradigm" (*McKeown, 1979*). The second issue shifted from the earlier focus on the ways in which "a Western medical technology" could be transferred to look at the problems of social, economic, and cultural conditions which reduce the effectiveness of the technology (*Rifkin and Walt, 1986; Bonair, Rosenfield, and Tengvald, 1989*).

These issues follow from two different arguments among health professionals. One group argued that we should focus on the efficacy of interventions (*Walsh and Warren, 1979*) and concentrate on transferring existing technology as quickly as possible (*Grant, 1982*). The belief is that once an intervention is successfully implemented, the technology will also transfer to the society so that a new value system will develop. The other group argued that the medical technologies could only be effective when the instruments themselves were an integral part of the development of the society to which they were transferred. Each society evolves in its own way, in its values and institutions, which are a pre–condition for assuring effectiveness of "Western medical technologies". One of the most important considerations for this debate is that the transfer of technologies meant not only the transfer of vaccines, ORS, or antibiotics but also the transfer of the "Western medical paradigm" (*Bonair, Rosenfield, Tengvald, 1989*). By involving the community in creating appropriate pre–conditions, the western medical technology can itself be transformed to suit the culture and human resources available (*Bonair, Rosenfield, Tengvald, 1989*).

The result of these two viewpoints has been a continuing debate between those who focus on the programs by which intervention are introduced and those who focus on the process through which the intervention might be accepted (*Rifkin and Walt, 1986*). Translation of these two different lines of thought leads to the articulation of two different concepts of health services, namely "comprehensive primary health care" (*CPHC*) or so called "primary health care", and "selective primary health care" (*SPHC*) (*Walsh and Warren, 1979*). The CPHC approach has a very broad scope which includes: health education, food supply and nutrition, water and sanitation, maternal and child health programs, immunizations, prevention and control of locally endemic diseases, treatment of common diseases and injuries, and provision of essential drugs (*WHO, 1978*). On the other hand, SPHC only constitutes health care directed at preventing or treating the few specific diseases that are responsible for the greatest mortality and morbidity in less–developed areas for which interventions of proved efficacy exist (*Walsh and Warren, 1979*). An example is the promotion of a standard child survival intervention package: Growth monitoring, Oral rehydration therapy, Breast feeding promotion, and Immunization (*acronym: GOBI*) by UNICEF (*Grant, 1982*). This package is sometimes extended to include Female education, Family spacing, and Food supplements (*GOBI–FFF*).

Although it may be argued that there is intrinsically no difference between CPHC and SPHC at the population level (*Gish, 1982*), there are two fundamental differences in their philosophical bases (*Rifkin and Walt, 1986*). The comprehensive approach sees health as a process dependent on individual knowledge and choice, of which medical intervention is only one, and often not the most important, input for improving the health status of a population. On the other hand, the SPHC approach is premised on the fundamental assumption that health improvement comes as a result of programs based on medical and technological interventions. Then it is commonly assumed that the health provider is the key to the success of the intervention. Consequently resources are increasingly directed into vertical programs that seek quick technical solutions to health problems rather than into integrated programs which address a wider range of development issues over the long term.

The CPHC approach relies on the fact that the control of the outcome of medical interventions lies in the hands of those who use or should be able to use the intervention. It assumes that the means by which this choice can be implemented depends on the social, political and economic conditions of individuals and the greater population, to which health providers only contribute but have little control over. Mosley (*1988*) suggested that polarization between CPHC and SPHC is unnecessary. Certainly, a technology–only strategy is inadequate, but it is in the right direction for bringing effective medical technologies to the population instead of being limited to clinic or hospital services.

Despite these differences SPHC is being implemented in many LDCs in the form of top–down programs. This intervention is being criticized as being technologically driven with overly optimistic expectations (*Wisner, 1988*). Nevertheless, recently Grant (*1988*) stated that at least 50 percent of child deaths can be dramatically reduced by low-cost interventions. These interventions involve informing and supporting parents in basic and inexpensive actions such as: 1) getting their children immunized, 2) using ORT for diarrheal diseases, 3) maintaining exclusive breast feeding in the early months, 4) applying new knowledge about when and how to introduce other foods, 5) recognizing the danger signs of acute respiratory infection, 6) spacing births at least two years apart, 7) enrolling prenatal care, and 8) applying hygienic practices. Threats to the lives and normal growth of children can be prevented by diffusion of such interventions on a large scale which almost all parents can act upon, and which governments could afford to facilitate even in difficult economic times (*Grant, 1988*). Lack of empirical findings, however, will result in continuing debates about selection between CPHC and SPHC (*Rifkin and Walt, 1986*).

In the following sections each component of selective child survival interventions will be reviewed. The characteristics and effectiveness of each intervention will be briefly discussed, with particular emphasis on reducing probability of dying and on improving the nutritional status of children under 5 years of ages.

2.2.1 Growth Monitoring

Growth monitoring is being promoted world-wide, particularly by UNICEF, as one of the essential parts of child survival interventions (*Grant, 1982*). There are many forms of implementation of growth monitoring. Growth monitoring may be defined as an operational strategy of enabling a mother to visualize growth or lack of growth in her child and to receive specific, relevant and practical guidance in which mother, family, and community can act to assure health and continued normal growth in her child (*Rohde, 1988*). It is believed that faltering of child health is the best single indicator of incipient problems in child health and development (*Taylor, 1988*). Consequently, most growth monitoring programs have concentrated on promoting the use of growth charts to benefit an individual child. However, growth monitoring itself is not expected to give a direct benefit to a child, since a two–stage process of screening and intervention is needed (*Hendrata and Rohde, 1988; Rohde, 1988; Taylor, 1988*).

In general, growth monitoring is expected to contribute various objectives (*Hendrata and Rohde, 1988; Rohde, 1988; Gerein, 1988*). Some of these objectives are: 1) to assist community health workers to diagnose children who are suffering from, or are in danger of suffering from, malnutrition, 2) to select those children who are seriously malnourished and who may need referral to clinics or hospital, 3) to assist health workers to educate mothers about child growth and nutrition, 4) as a vehicle for providing health interventions, including immunization and vitamin A supplementation, and 5) as a vehicle for community participation and development. To achieve these objectives, the key element of success is a communication approach that involves mothers and health workers (*providers*) in a meaningful and reinforcing dialogue aimed at promoting better child health behaviors (*Rohde, 1988*).

In the past, growth monitoring was performed at the clinic's bases, and less than two decades ago it become a part of community health programs. In the early 1970s, the Indonesian government moved the responsibility of growth monitoring from clinics to the community (*Priyosusilo, 1988*). This event was concurrent with the development of an embryonic primary health care program in Indonesia, which has a stronger emphasis on the health education but less on the delivery of health services(*Government of Indonesia–UNICEF, 1989*). Since UNICEF adopted growth monitoring as its operational strategy in 1982 (*Grant, 1982*), the use of growth monitoring as a basic strategy for child survival intervention has become an important impetus in the developing countries.

Although growth monitoring is being adopted in many countries, including Indonesia (*Priyosusilo, 1988*), its effectiveness has been evaluated in a very few. Furthermore, growth monitoring is arguably the most difficult of GOBI strategies to carry out, but it has received a little research (*Gerein, 1988; Nabarro and Chinnock, 1988*). The usefulness of growth monitoring in terms of focusing health intervention in young children is undeniably important; nevertheless the effectiveness of this growth monitoring is controversial (*Cape, 1988; Gerein, 1988; Gopalan and Chatterjee, 1985*). In the implementation of growth monitoring programs, the use of a growth chart for screening of malnourished children is the most serious problem in the program (*Gopalan and Chatterjee, 1985; Hendrata and Rohde, 1988*). Although growth charts may theoretically be useful screening tools, in practice much evidence would indicate that they often lead to wrong conclusions. Gopalan and Chatterjee (*1985*) reviewed a number of studies on the use of growth charts for promoting child nutrition. There were many inaccuracies found due to faulty scales, weight measured wrongly, age given inaccurately, and "dot marked" at the wrong point on the chart. McLarren and Lennox (*1986*) also found that often nutritional status was recorded incorrectly by health workers. However, when growth monitoring is well implemented, health workers can identify malnourished children and execute the programs as accurately as professional health workers, as was demonstrated in Indonesia (*Wilopo, et al, 1980*) and India (*Gopaldas, 1988*).

One goal of screening in growth monitoring is to select children who are seriously malnourished and may be in need of special intervention or referral to clinic or hospital (*Rohde, 1988; Hendrata and Rohde, 1988*). An obvious response to the findings of malnourished children would appear to be either food supplementation or individual care in clinic or hospital, depending the cause of malnutrition. However, many studies found that this is rarely the response (*Gerein, 1988*). Reid (*1982*) reported that child's weight going up or down had "no effect" on the amount of nutritional advice given. Because of these reasons, there is no evidence to show that growth monitoring alone improves nutritional status of children directly (*Ashworth and Feachem, 1986; Priyosusilo, 1988*).

The growth chart is printed on a growth card, which has a wider purpose than just serving as a screening tool for malnourished children. Besides the use of the card for weight recording, it is also designed as "an educational tool" to teach mothers about nutritious foods and better feeding practices for children, to schedule immunizations and vitamin A supplementation, and to provide instructions on how to make "home made" an oral rehydration salt (*ORS*) (*Rohde and Northrup,* *1987; 1988*). These are important aspects of health education emphasized in Indonesia (*Government of Indonesia–UNICEF, 1989*) and other LDCs. It is expected that health worker will routinely diagnose the current weight of the children and to take time to talk to individual mother about their child's weight and advise them about feeding and breast feeding practice, immunization, vitamin A supplementation, and the use of ORT during child diarrhea (*Rohde, 1988; Hendrata and Rohde, 1988*). An indirect benefit of growth monitoring is that it gives women a chance to meet other women and discuss the health matters of their children.

Unfortunately, there is some evidence that the educational aspects of growth monitoring performed by providers fails (*Cape, 1988; Gerein, 1988; Gopalan and Chatterjee, 1985*). Even if a child was diagnosed as being malnourished, usually only a few minutes conversation between the mother and health worker took place and the advice was often too brief and non-specific. There is good evidence that mothers and health workers themselves do not understand the meaning of growth monitoring and the information printed on the card (*Gopalan and Chatterjee, 1985*). Unless mothers and health workers have some preconditions to understand the overall objectives of growth monitoring, the impact attributed to health education may not be seen. Obviously the most important precondition for this system is an adequate education for mothers and health workers.

Recently, many growth monitoring programs have been integrated with other health services such antenatal care, family planning services, immunization, and vitamin A supplementation (*Grants, 1988*). In Indonesia, this integrated service is called "Integrated Service Post" or "POSYANDU" (*Pusat Pelayan Terpadu*). In most cases, the implementation of this service depends on community health workers (*health cadres*), even though the government's health center (*PUSKESMAS*) is heavily involved in this process. This is an effort to maintain the vehicle of continuing participation from the community in the health program. The main justification of this approach is the use of a growth monitoring program as a catalyst for action on the part of mothers, health cadres, and their community in health services for children. Thus POSYANDU approaches a community as a subject of rather than an object of intervention.

Evidence of the effectiveness of growth monitoring as a catalyst for action on the part of mothers, health workers, and their community in health services is unclear (*Gerein, 1988*). It is suggested that growth monitoring is an important element to increase effectiveness of health education, utilization of ORT, immunization, attendance of antenatal care, acceptance of family planning method, and vitamin A distribution. But these claims have not been supported by well-designed research studies. There are a few studies that could be said to show, even indirectly, that growth monitoring is a critical element in improving the delivery of health care, or that it contributes substantially to increased utilization and nutrition services at the population level (*Priyosusilo, 1988*).

In summary, the problem of growth monitoring seems to lie in the organization and management of health services, in the knowledge and creativity of health personnel, in systems of supervision and management, and in the integration of preventive and curative care. The "efficacy" (*supposed potential*) of growth monitoring will not come to fruition unless attention is paid to the essential issues of planning, training, resources, supervision, management and evaluation in the programs. Introducing growth monitoring into child survival interventions that have serious organizational and resource difficulties will not increase the impact of child survival intervention; in fact it could reduce the effectiveness by removing limited resources from other important activities. Moreover, when intervention does not show a direct or indirect impact on the community, reduced participation or ignorance of the program will result in serious consequences to the implementation of similar programs in the future (*Bonair, Rosenfield, and Tengvald, 1989; Cape, 1988*).

2.2.2 Oral Rehydration Therapy

Oral rehydration therapy (*ORT*) is the name given to a range of actions designed to treat and prevent dehydration of a child during episodes of diarrhea by the mother giving the child fluids. When a child has diarrhea, dehydration can often be prevented by giving the child adequate water and other liquids, including breast milk. Ideally, the child can be given an oral rehydration salt (*ORS*) solution, which is increasingly more available through health centers and pharmacies in many LDCs. If this specially formulated ORS is not available, parents can still make it up from a combination of a sugar, salt, and water in the right proportions. Several traditional remedies such as vegetable or cereal soups and rice canjees are also effective in preventing dehydration. Only in a very small proportion of cases of diarrhea is intravenous rehydration therapy really necessary (*Black, 1984; Hirschhorn, 1980*).

According to Grant (*1988*), a total of 90 countries now have national programs to promote the use of ORT. “World production” of ORS has reached 270 million liters a year. In 1988, 47 developing countries began mass production of the ORS, and it is estimated that they will contribute about 56 percent of world output. As result of this expanding production, approximately 20 percent of children with diarrhea are now being treated with either ORS packets or “home–made” oral rehydration solution.

WHO has targeted that by the year 1989 at least 50 percent of children with diarrhea should be treated with ORT. Reaching such a target, however, requires extraordinary efforts in overcoming the most serious problem for the project, which is the lack of health providers properly trained in the use of ORT (*WHO, 1989*). It is planned that by the year 1990 at least a quarter of health workers world-wide would have been re-trained in the use of ORT.

Acute diarrheal deaths may constitute 50-60 percents of all diarrheal deaths (*Black, 1984; Grant, 1988*). It is well accepted that most of death attributed to diarrhea result from a depletion of water and electrolytes, and nearly all of its can be prevented by the prompt administration of ORS (*Hirschhorn and Denny, 1975, Hirschhorn, 1980*). However, the appropriate management of a diarrhea episode seems to be: a) the prevention of dehydration through proper treatment in the home with ORT, b) the treatment of dehydration in the health care system with ORT, c) proper feeding of the child during and immediately after diarrhea, and d) selective use of intravenous fluids for severely dehydrated child and antibiotics for a bacterial dysentery (*Dale and Northrup, 1987; Taylor and Greenough, 1989*). It has been reported that food–based ORT solutions have also been used in the management diarrhea, especially as a supplement of food required to maintain nutrition during diarrhea treatment. It is suggested that if food polymers (*i.g., starches and proteins in rice canjee*) are substituted for glucose or sucrose in the ORT formula, the duration of diarrhea will be reduced (*Dale and Northrup, 1987; Rohde and Northrup, 1987*).

The first proof of effectiveness of ORS came in its application in a large cholera outbreak among refugees from Bangladesh who fled to Calcutta from a war in their country (*Mahalanabis, et al., 1973*). Since this study was published, many community-based ORT programs have been conducted in LDCs, including in Indonesia (*Chowdhury, 1986; Lerman et al., 1985; Parker et al., 1985; Tecke, 1982; Winardi, 1984*). Unfortunately, most of the programs had their own scopes and approaches, and this makes interprogram comparisons for effectiveness difficult. In many programs (*Kielmann and McCord, 1977*), including Indonesia's (*Government of Indonesia–UNICEF, 1989*), the use of ORS is an integral part of the on–going health delivery system. Programs vary from distributing ORS packets (*Aras and Jha, 1987; Chen et al., 1980; Corrales, et al, 1983; International Study Group, 1977; Rahaman et al., 1979*), to merely distributing spoons for measurement of salt and sugar (*Zimicki et al., 1984*). Administration of the ORT programs can also differ. For example, some program teach selected elderly women or "bari mothers" (*Bhatia et al., 1980*), establish depot holders (*Rahaman, et al., 1979*), and others teach family members in the household directly. A large–scale and intensive household teaching ORT is reported by the Bangladesh Rural Advancement Committee (*BRAC*) (*Abed, 1983; 1987*). The study demonstrated a large public health education programs on ORT that can be successfully implemented in a rural developing society without sacrificing the quality of program.

The impact of community–based ORT programs to reduce diarrhea–related mortality have been reported in a few studies (*Rahaman et al, 1979; Kielmann and Cord, 1977; Kielmann, et al., 1979*). Little is known about the net impact on infant and child mortality, since in many studies the target of the program is not limited to children, but also includes all cases of diarrheal diseases in adults. Some studies suggested that a community–based ORT program can reduce the risk of growth faltering among children (*International Studies Group, 1977*) and reduce overall hospitalization rates among diarrheal diseases (*Egemen and Bertan, 1980*).

Reduction in total mortality rates have usually not been as great as would be expected from the declines in diarrheal deaths. There is increasing concern over the number of deaths prevented attributed to ORT now emerging (*Taylor and Greenough, 1989*). The number of deaths averted projected seems over-optimistic. There are at least four possible reasons behind this skepticism. First, the expected number of deaths averted from ORT may be too high because the number was taken from case studies in areas of high diarrhea prevalence and the ORT intervention was perfectly implemented. In another words, there may be biased estimates of both effectiveness and incidence rates. Second, if children can be saved by ORT from one or more episodes of diarrhea and nothing is being done for other "competing risks", there is a likelihood that those children who have recovered from diarrhea will die from other diseases. Third, a major concern is the sustainability of some mass ORT programs when funding is eventually shifted to other problems.[1] Fourth, ORT is merely a curative measure, and without supports from other prevention actions such as improvement of water supply and sanitation, the effectiveness of ORT in reducing mortality is limited (Taylor and Greenough, 1988;

[1]The collapse of the efforts at global malaria eradication is a good example.

2.2.3 Breast–Feeding Promotion

The third low-cost opportunity to improve child survival in LDCs is the campaign to halt and reverse the increasing trend from breast to bottle–feeding. Breast–feeding promotion has many targets, such as the improvement of medical attitudes and hospital practices in encouraging breast–feeding, the control of irresponsible promotion and marketing of artificial infant formulas, and the promotion of better nutrition for mother, and to reassure them that breast-feeding is the best (*Hull, Thapa, and Wiknyosastro, 1989*). By this simple campaign, UNICEF projected that one million infant lives a year could be saved (*Grant, 1982*).

This action was based on the fact that breast feeding is better than bottle–feeding (*Huffman and Lamphere, 1984; Winnikof, 1981*). Breast milk is more nutritious, more hygienic, cheaper, and immunizes infants against common infections. Exclusive breast–feeding for the first 6 months of life, and breast–feeding plus food supplements thereafter, is highly protective against diarrhea and diarrhea–associated death (*Feachem and Koblinsky, 1984*). Recently, a case–control study by Clemens et al. (*1990*) indicates that breast feeding was associated with a substantial reduction of the risk of severe cholera. Such breast–feeding behavior also protects against a variety of other infections, and it may enhance growth, may prolong the period before the birth of next siblings, and may stimulate bonding between the mother and child (*Huffman and Lamphere, 1984; Winnikoff, 1981*). The dangers associated with bottle feeding are likely to increase if family does not understand that mixing milk-powder with contaminated water in an unsterile bottle means more illness (*Surjono, Ismadi, and Rohde, 1980*), more malnutrition, and a greater risk of death (*Butz, DaVanzo, and Habicht, 1982; DaVanzo, 1984*).

Regrettably, the trend toward bottle-feeding in LDCs, including Indonesia, has been increasing in the last two decades (*WHO, 1989*). The decline of good breast–feeding practices is more likely among affluent families and among families living in urban areas. WHO (*1989*) reported that the prevalence of breast–feeding, especially after 3 months, is highest in Asia and Africa, and lowest in Europe and North America. In industrialized countries, extended breast–feeding is more common among educated, economically advantaged mother, whereas in developing countries it is greatest among the rural poor, both in terms of prevalence and duration (WHO, 1989).

Breast–feeding rates can be increased through promotion by hospitals, health professionals, health workers, mass-media, schools, and mothers themselves (*Grant, 1988*). For example hospitals can keep mothers and babies together in maternity wards (*rooming-in*) and encourage breast-feeding from birth. They can also refuse free infant formula and ban feeding–bottles from the ward, and teach the importance and techniques of breast-feeding to all nurses and medical students. Health professionals and health workers can explain the benefits of breast–feeding to all mothers. The media can inform the importance of breast–feeding, as well as refuse advertising for breast-milk substitutes or even report local violation of the infant formula code. Schools should make sure that no child leaves school without knowing the importance of breast feeding. Even mothers themselves can advise and encourage younger mothers in their families and neighborhoods to continue to breast–feed at least 6 months. All of these approaches are parts of the UNICEF's action plans (*Grant, 1988*).

Many studies have documented a positive association of breast feeding on infant or child survival (*DaVanzo et al., 1983; Koenig et al., 1990; Palloni and Millman, 1986; Palloni and Tienda, 1986; Retherford, et al., 1989*). The cessation of breast-feeding increases the mortality risks of children through the first year of life. Thereafter, breast-feeding seems to make little difference for mortality risks. The association between duration of breast–feeding and mortality is likely to be explained by the effect of the following birth interval on child survival, even though breast feeding has direct effects on both the following birth interval and child survival (*Retherford et al., 1989*). Breast feeding has a direct effect on the following birth interval because of its effects on lengthening postpartum amenorrhea (*Bongaarts, 1987; Gray, 1984; 1989*). Breast feeding has a direct effect on child survival because weaning may expose the child to less adequate nutrition and increase the risk of diarrheal diseases (*i.e., cholera*) from contaminated bottle-feeding, water, and food (*Butz, DaVanzo, and Habicht, 1982; Clemens et al, 1990*), especially among poor families.

The effects of breast feeding and interbirth intervals are closely related. Prolonged lactation induces longer postpartum amenorrhea, which increases the likelihood of longer intervals between births. On the other hand, a conception shortly after a birth can trigger cessation of breast–feeding due to hormonal stimulation or behavioral reasons. Retherford et al. (*1989*) shows that in Nepal breast feeding strongly explains the effects of the following birth interval on childhood mortality during the first 18 months, but offers less support for the effect of the following birth interval on childhood mortality between 18 and 60 months of age. However, breast feeding did not explain the effects of preceding birth interval on childhood mortality. The findings of this study differ to some extent from those a study by Palloni and Millman

(*1986*) in 12 Latin American countries, which suggested that breast feeding does little to explain the effects of the following birth interval on early childhood mortality. The difference of breast feeding between Latin American countries and Nepal probably occurs because women generally stop breast–feeding sooner, childhood mortality is lower, and contraceptive prevalence is much higher in Latin American countries.

2.2.4 Immunizations

The fourth element of child survival interventions is the immunization of children against tuberculosis, diphtheria, tetanus, pertussis (*whooping cough*), poliomyelitis, and measles. The WHO (*1982*) recommended to immunize children with the following schedules:

a) soon after birth, BCG for tuberculosis and the first oral polio vaccination (*OPV1*);

b) at six weeks, the first injection against diphtheria, pertussis and tetanus (*DPT1*) and OPV2;

c) at ten weeks, DPT2 and OPV3;

d) at fourteen weeks, DPT3 and OPV4;

e) at 9 months, the measles immunization.

Between 1982 to 1984, the world-wide supply of vaccines by UNICEF has increased almost four-fold from 129.7 to 494 millions doses (*Grant, 1988*). However, current estimates suggest that only 70 percent of infants in developing countries will be covered in 1990 (*Henderson, et al., 1988*). Less than two–thirds of the children in the developing world are now receiving a first dose of DPT vaccine; and only half of them are completing the full course of three injections. Only one half are being immunized against polio and 39 percent against measles. Considering that these six diseases are claimed to be responsible 4.5 million deaths each year, UNICEF has estimated that 1.4 million young lives were saved last year from immunization alone.

Neonatal tetanus

Neonatal tetanus can be prevented by giving the tetanus toxoid (*TT*) vaccine to the mother during pregnancy. Risk factors for neonatal tetanus include the environmental and socioeconomic level of the households, delivery at home, delivery by an untrained birth attendant, and traditional umbilical cord care practice (*Foster, 1984; Ross, 1986*). An infant has the risk of infection in the umbilical stump during the first two weeks after birth. Without any treatment, about 70–90 percent of children with neonatal tetanus will die. Even with treatment by experts, the case fatality rate of neonatal tetanus is still above 50 percent. In LDCs, neonatal tetanus mortality rates vary from 3 to 30 per 1,000 live births (*Foster, 1984; Smucker, 1980*); it constitutes about 8 to 60 percent of all neonatal deaths. In Indonesia, estimated mortality rates for neonatal tetanus varies from 7 to 15 per 1000 live births (*Arnold, Soewarso, and Karyadi, 1986; Boediarso, Putrali, and Prihartono, 1984; Kantor Wilayah Departmen Kesehatan Propinsi NTT, 1985*).

The program strategy is mainly focused on two aspects: 1) convincing pregnant women that they should receive two doses of tetanus toxoid, and 2) training birth attendants to improve their knowledge and skill in delivering babies, and providing them with the basic equipment to do so (*Foster, 1984*). Because of the difficulties experienced in earlier programs for reaching pregnant women, some countries have been emphasizing vaccination of all women of child–bearing age. For example, Indonesia has started to modify their program by introducing "a bride immunization certificate", which requires a bride to have TT immunization before "a marriage certificate" is granted (*Lanasari and Rosenberg, 1989*).

The best test of the effectiveness of TT immunization in reducing neonatal deaths was demonstrated in Columbia more than two decades ago (*Newell et al., 1966*). This study was double–blind control trial for pregnant women with two different treatment groups: one– and two–shot TT immunizations. Two–shot immunization was giving excellent protection from neonatal deaths. In this case the control group (*341 live births*) had a neonatal mortality rate of 77.8 per 1,000 births and the treatment group (*347 live births*) had 0 neonatal tetanus death. On the other hand, one shot of TT immunization only reduced less than half of neonatal deaths. The control group (*270 live births*) had 70.4 neonatal tetanus deaths per 1,000 live births, and the treatment group (*224 live births*) had 40.2 neonatal tetanus deaths per 1,000 live births. This protective effect of tetanus toxoid given to non-pregnant women was also shown in the Matlab Cholera Vaccine Trial, in which tetanus-diphtheria toxoid was used as a placebo (*Black et al., 1980*). Other reports have supported these findings (*Schofield, 1961*), including from Indonesia (*Arnold, Soewarso, and Karyadi, 1986; Solter et al., 1986*). While the effect of TT on neonatal tetanus deaths is obvious (*Jones, 1983*), the overall impact on the infant or child mortality rate is unclear (*Ross, 1986; Solter et al., 1986*). This may be due to the fact that there are many competing risks of dying which act in the later period.

The second strategy to reduce the number neonatal tetanus cases is the training of birth attendants. The aim is for birth attendants to improve their hygienic practices and to use of sterile equipment for the cutting and nursing of the umbilical cord. However, a study by Solter et al. (*1986*) in Aceh, Indonesia did not show a significant difference in terms of reduction of neonatal deaths between trained and untrained birth attendants. This may be due to the fact that most of traditional birth attendants were old and illiterate and therefore intervention or training did not change their old practices.

Tuberculosis

Bacillus Calmette-Guerin (*BCG*) vaccine has been widely used in LDCs, yet its effectiveness in the field and its role in the control of tuberculosis remain unconfirmed by a controlled clinical trial. In 1979 and 1980, the Tuberculosis Prevention Trial Group from Madras reported that BCG vaccination conferred no protection whatsoever against bacteriologically conformed pulmonary tuberculosis. Although this study was based on large–scale community trials, but results of this study did not necessarily apply to vaccination of a newborn, since childhood tuberculosis had not been observed in this study.

In North America as well as in Europe, however, early use of the vaccine was encouraging (*Aronson, Aronson, and Taylor, 1958; Baudouin, 1935; Curtis, Leck, and Banford, 1984; Towsen et al., 1942; Wallgreen, 1934*). On their review articles, Clemens et al. (*1983*) identified eight controlled trials which were methodologically and statistically sound but showed efficacy rates ranging from $+82$ to -56 percent.[2]

[2] The efficacy rate is calculated as follows: (((tuberculosis attack rate in controls)–(tuberculosis attack rate in vaccinees))/(tuberculosis attack rate in controls)) times 100%.

It was concluded that because the trials with the best methodological quality and greatest statistical precision reported a higher efficacy, the evidence suggests that BCG vaccination can indeed confer a high degree of protection against tuberculosis, including for children (*Aronson, Aronson, and Taylor, 1958; Towsend et al., 1942*).

In the case of vaccination against tuberculosis, new controlled clinical trials seem unlikely because of their expense, the time and sample size required to obtain significant results, and the ethical or moral grounds to consider comparative trials of two or more vaccines when its has already become a common practice. Therefore, observational studies can be performed to substitute for controlled clinical trials. Since the reports of the Tuberculosis Prevention Trial Group published in 1980s, several observational studies appeared from widely different parts of the world (*Houston, et al., 1990; Padungchan et al., 1986; Tidjani, Amedome, and ten Dam, 1986*), including Indonesia (*Sutrisno, et al., 1983*). All studies looking at BCG in infants and children have demonstrated 50 to 60 percent protection against tuberculosis. Smith (*1982*) also summarized 10 case-control studies in which the range of protection extended from a high of 90 percent to a low of 2 percent. Highest effectiveness was found in two studies of tuberculosis meningitis (*Smith, 1982*). However, interpretations of these observational studies could not be inferred to the vaccine efficacy directly (*Comstock, 1990*). The apparent protective effect of vaccine may be overestimated if the BCG vaccination program produced almost complete coverage among wealthy people who rarely developed the disease of interest and almost no coverage among the poor who were at higher risk of having tuberculosis. On the other hand, when a vaccination program is only targeted to a population at the lowest socioeconomic levels, then an underestimated impact would emerge.

Infant and child deaths associated with tuberculosis are difficult to measure. Besides the fact that tuberculosis contributes to death associated with lower respiratory infections, the meningitis and systematic (*miliary*) tuberculosis both have a high case fatality rate (*Clemens et al., 1983; Smith, 1982*). Tuberculosis can also result in growth faltering, which reduces immunity to other infectious diseases (*Styblo, 1989*).

The current practice in child survival intervention is giving one shot BCG vaccine as soon as possible after birth (*WHO, 1982*). Some authors suggest that whatever the overall protective effects of BCG vaccine, protection is greater against more serious form of tuberculosis, such as miliary and meningitis. Therefore, the current practice of BCG vaccination of infants and child should continued (*Styblo, 1989; WHO, 1982*).

Pertussis

Pertussis is a major direct cause of childhood mortality by way of respiratory infection and its complication as a precipitating factor of severe malnutrition. The epidemiological pattern of pertussis is less understood compared to other childhood diseases preventable by immunization. The majority of studies have been conducted in African countries (*Morley et all, 1966; McGregor et al., 1970; Voorhoeve et al., 1978*), and it was reported that case fatality rates range from 1.3 to 7.3 percent. The population–based cohort study by Voorhoeve et al. (*1978*) showed that among 953 cases found within 3 years observation, 21 of them died within 3 months of infection (*4.1 percent of all deaths in the 0-15 age groups*). Twelve of these 21 deaths were directly attributed to pertussis. The case fatality rate directly associated with pertussis is 1.3 percent and the overall case fatality rate associated with pertussis is 2.2 percent.

Most deaths attributed to pertussis occur within one month of onset (*Foster, 1984*). However, symptoms from pertussis can persist longer than one month with anorexia and vomiting. Undernutrition associated with these symptoms were reported by Morley (*1963*) and Mata (*1978*).

To reduce the mortality and undernutrition associated with pertussis, infants should receive immunization as early as possible in order to be protected against the natural diseases prior to the high risk periods at age below one year. Immunization is given in the form of a Diphtheria Pertussis and Tetanus vaccine (*DPT*), which is usually given together with trivalent oral poliovirus vaccine (*TOPV*). It is recommended in all countries that routine immunization with DPT and TOPV can be safely and effectively initiated at six weeks of age (*Halsey and Galazka, 1985*). Each child should be scheduled to receive DPT and TOPV three times. However, dropout rates after the first of the three required doses are as high as 50 percent (*Henderson et al., 1988*). This noncompliance to immunization results from several factors: the lack of belief in the effectiveness of the vaccine, side effects of immunization such as sore arms and high fever occurring after immunization, and the lack of knowledge or perception of illness about pertussis (*Foster, 1984; 1989; Halsey and Setler, 1983 Streatfield and Singarimbun, 1988*).

There is no publication reported about effectiveness of pertussis immunization in population based studies. Vaccine efficacy for protected children has been estimated at 85 to 95 percent (*Church, 1979*).

This study is also supported by Cook (*1978*) using hospital data. In the absence of the population-based data, it is believed however that DPT immunization can reduce child mortality (*Grants, 1982*), and it is also believed to play a key role in preventing undernutrition (*Foster, 1984*).

Diphtheria

Diphtheria is a highly contagious disease, especially in crowded, susceptible populations. It may be spread by direct contact (*cutaneous*) or aerosol droplet (*respiratory*), as well as by fomites or, more rarely, by milk (*Hewlett, 1985*). Infected children may be asymptomatic or may experience a single acute attack with systematic toxicity or a series of experiences of an acute attack with systemic toxicity and a fatal outcome, depending upon their immune status and the location and the extent of the infection. The case fatality rate (*CFR*) in nasopharyngeal or tonsillar infection may exceed 50 percent because of severe systemic toxicity, marked by myocarditis, cardiac conduction abnormalities, circulatory collapse, and paralysis resulting from the toxin.

WHO (*1982*) has recommended that all infants by one year of age should receive three doses of combined diphtheria, tetanus toxoid and pertussis vaccine (*DPT*) at intervals of at least four weeks. UNICEF's child survival intervention follows this recommendation. Over the last three years, the proportion of children in LDCs covered by DPT vaccine has increased about 7 percent a year, and it is projected that by the end 1990, 70 percent or more children will be immunized using DPT vaccine (*Henderson et al., 1988*).

Some data suggest that the use of vaccines has been associated with remarkable decreases in the incidence of morbidity and mortality from diphtheria in many areas of the world (*Griffith, 1979; Ornstein et* *al., 1983*), including Indonesia (*Kim–Farley, Soewarso, and Adhyatma, 1987*). However, little is known about the impact of DPT immunization on the total mortality of children under 5 years. All evaluations of the effectiveness of vaccines have been conducted by measuring both the serologic response and the clinical protection against disease (*Orenstein et al, 1983*) and none on the total mortality impact.

Poliomyelitis

Paralytic poliomyelitis is an important public health problem in the developing world, in part, because of the fear evoked by the disease. In a lameness survey, a case of poliomyelitis is defined as any patient with acute flaccid paralysis with atrophy, no decrease in sensation, and a history of acute onset with no progression (*including any child less than 15 years of age diagnosed with Guillain Barre syndrome*) for whom no other causes can be identified (*WHO, 1982*). In 1986, 28,773 cases of poliomyelitis were reported to WHO office by 173 countries with an estimated population of 4,772 million persons. For 1988, 26,621 cases of poliomyelitis have been reported from 127 countries with an estimated population of 4,326 million persons. These data suggest that the incidence rate of poliomyelitis is about 0.6 per 100,000 population. The Southeast Asia region accounted for 52.2 percent of the global total in 1986. It was followed by the Eastern Mediterranean region (*20.2 percent*), African region (*12.6 percents*), Western Pacific region (*11.0 percent*), the Americas region (*32 percent*), and European region (*0.9 percents*). WHO (*1989*) reported that trends of regional incidence rates for poliomyelitis over a 15 year period from 1974 to 1988 were declining, especially since 1982. Current estimates of prevalence of poliomyelitis in the American Continents (*North and South Ameri-*

cas) range $3 - 7$ cases per $1,000$ children.

There are three types of poliovirus (*type 1, 2, and 3*) responsible for this disease. Other types of viruses do not cause disease. These are called Wild polio viruses that are the naturally occurring types from which the oral polio vaccine (*OPV*) was derived through a process of attenuation (*Katona and Jones, 1983*). The great majority of wild poliovirus infections are asymptomatic. Only one in about 500–1000 persons infected with wild poliovirus develops paralysis.

WHO (*1982*) recommended that all children receive a minimum of three doses of OPV during the first year of life. However, the data indicate that two doses of OPV will provide adequate protection for 75 percent or more children vaccinated (*Katona and Jones, 1983*). A minimum interval of approximately two months between doses is recommended.

The effectiveness of OPV immunization is usually measured in three ways: 1) the induction of a specific serum antibody, which can be determined by blood test of previously seronegative vaccines; 2) the induction of infection of the intestinal mucosa, which can be demonstrated by isolation of poliovirus from feces vaccines; 3) the prevention of paralytic disease due to wild poliovirus, which can be determined by epidemiological follow–up of vaccinee.

There is growing optimism that poliomyelitis can be eradicated in some parts of the world. In May 1988 the Forty-first World Health Assembly committed WHO to the global eradication of poliomyelitis by the year 2000. The broad objective of this eradication initiative is to achieve by the year 2000 zero cases of clinical poliomyelitis associated with wild poliovirus, and to find no wild poliovirus identified world wide through a sampling of countries and the environment.

Poliovirus has virtually disappeared in the industrialized countries of the Americas, Europe, and Western Pacific regions. In the American region poliomyelitis continues to have a steady decline, with 917 cases reported in 1986, 642 cases in 1987, and 341 cases reported in 1988. Thirty countries in this region have reported no cases since 1984. This region is rapidly approaching the goal of eradicating poliomyelitis from the entire American continent by the end of 1990 (*WHO, 1989*), the goal LDCs hope to achieve by the year 2000.

Measles

Measles and its complications are major killers of young children in LDCs, but it is preventable by vaccine. Measles can be prevented by a single dose of live vaccine given at or after 9 months of age (*Halsey, 1983; Cutts et al., 1990*). In population based studies the best evidence of effectiveness of measles immunization was reported by Kasongo Project Team (*1981*). It was shown that measles vaccine could reduce the risk of death during the age of maximum measles exposure (*age 7–21 month*). Using a life table, the survival probability of a vaccinated cohort was demonstrated to be higher than for an unvaccinated cohort (*i.e., for age 7–21 months it was 0.975 versus 0.946*). The Kasongo Project Team (*1986*) also reported that measles is also decelerating growth of children at younger ages.

In LDCs, measles results in excessive mortality because complications are frequent and severe. Survivors of measles cases usually experience a marked loss of weight due to both diarrhea and an inability to eat and drink because of severe stomatitis, cough, and general malaise (*Walsh, 1983*). There is also some indication that post–measles cases suffer acute vitamin A, deficiency which may explain the higher susceptibility to acute respiratory infection, diarrhea, and blindness (*Reddy et al., 1986*). Catch–up weight gain can take longer than three months, and measles can precipitate severe malnutrition, either marasmus or kwashiorkor (*Walsh, 1983*).

Without prevention it is estimated that measles may cause about 2.1 million deaths annually, and contribute about 1 to 5 percent of total death children in LDCs. Reported case fatality rates for children with measles range from 1 to 28 percent, depending on the severity of complications and place of care (*Foster, 1984*). First evidence of measles as a major cause of child mortality was reported by Morley in 1963. Using hospital data, it was shown that the case fatality rate of measles patients was about 25 percent. Subsequent field studies in Africa and other countries suggested that case fatality rates are lower in the field studies than in Morley's hospital data (*McGregor, 1970; Wakeham, 1978; Kasongo Team Project, 1981, 1986; Koster et al, 1981; Aaby, 1988*).

In the community the high mortality caused by measles is usually attributed to malnutrition (*Foster, 1984; Nieburg and Dibley, 1986; Walsh, 1983*) and age at infection (*Walsh, 1983; Davis, 1982; Aaby et al., 1990*). Accordingly, it has been suggested that in the developed countries the decline in mortality due to measles has been a result of improved nutrition (*Mayer, 1969*) and higher age at infection (*Reves, 1985*). Community studies from LDCs, however, show that there was no association between premorbid state of nutrition and the subsequent risk of death from measles (*Aaby et al., 1983, 1988*). Instead, the high mortality in a severe epidemic of measles is associated with clustering of cases and the intensity of exposure in secondary cases in the household.

Recent studies by Aaby et al. (*1988*) showed that nutritional status (*weight–for–age*) did not affect the mortality caused by measles infection. They found that after intensive immunization the mortality among unvaccinated children was also declining, despite a lower age at infection and an increased prevalence of malnutrition. The incidence of isolated cases, however, increased in the period after introduction of measles vaccination. They suggested that as measles vaccination raises herd immunity and diminishes clustering of cases, it may reduce mortality among even unvaccinated children who contract the diseases. Measles vaccination reduces the occurrence of clustering cases, because some children have already been immunized before measles spreads in a given household.

There is evidence that a post–measles risk of mortality due to other diseases (*e.g., diarrhea*) is increased (*Kasongo Team Project, 1983; 1986*) and that an aversion of measles mortality by vaccination has a greater impact on child survival than mortality caused from measles. It is suggested that elevated post-measles mortality from other diseases can be avoided, despite the reduction of clustering of cases by immunization, reducing the risk of intensive exposure from measles virus (*Aaby, 1988*). It should be noted that the dose of viral exposure may be responsible for the severity of measles infection in children (*Aaby, 1986*). The high mortality caused by measles virus in LDCs, therefore, may be reduced not only by vaccination but also by sociocultural and epidemiological factors that help reduce clustering of cases and less intensive exposure to measles virus.

2.2.5 Family Spacing

A short birth interval may have deleterious effects upon a child's nutritional status and increases his risk of death. Explanations for these negative effects have centered largely upon two hypotheses: first, behavioral effects related to competition between siblings, and second, biological effects related to maternal depletion syndrome (*Gray, 1989; Ruzicka, 1984*). In addition to hypotheses regarded "sibling competition" and "maternal depletion syndrome", Blacker (*1987*) proposed "a birth crowding" effect, which influences the pattern of the transmission of infectious diseases and, in turn, can cause malnutrition or mortality.

The first hypothesis is based on the argument that in situations

where closely spaced pregnancies lead to two children of roughly comparable ages, the younger (*index*) child is likely to suffer malnutrition or death, either because the family is less likely to share limited familial resources such as food or care to this child, or simply because these limited resources are spread among more siblings. The second argument regarding the maternal depletion syndrome, describes a pattern of repeated, closely-spaced pregnancies, which provides insufficient time for the mother to adequately recover from the adverse physiological and nutritional demands associated with pregnancy, parturition, and prolonged breast-feeding. Moreover, under pressure of poor socioeconomic conditions within the family, women often lose energy in physical work. Under such conditions the woman cannot fully recover before the subsequent pregnancy, which may in turn result in outcomes of low birth weight baby and prematurity (*Miller, 1989*), all of which carries an intrinsically higher risk to the child of malnutrition or mortality during infancy and early childhood.

The higher proportion of child deaths with larger family size has been associated with the birth crowding hypothesis (*Blacker, 1987*). The increase in mortality is too great to be attributed simply to the effects of birth spacing. An additional factor resulting from birth crowding, which is being interpreted as a result of increased exposure to infection, has been proposed for this relationship. For example, Aaby (*1988*) suggested that case-fatality from childhood measles is higher in a crowded than in a non-crowded household.

There is considerable evidence for the advantages of longer intervals between births for the health of children at either end of the interval (*Hobcraft, McDonald, and Rutstein, 1983; Palloni and Millman, 1986; Palloni and Tienda, 1986; Palloni, 1989*). But there is less agreement about the ways in which closely spaced pregnancies effect children's health, and the circumstances which condition their impact (*Miller, 1989; Palloni, 1989*).

Recently, many authors questioned the magnitude of the association between length of the proceeding birth interval and the risk of death among infants and children (*Bongaarts, 1987, 1988; Miller, 1989; Potter, 1988a, 1988b; Trussell, 1988*). This question is important because the stronger conclusion that birth spacing (*per se*) affects infant and child mortality has been used as a justification for family planning. The claims is that family planning not only leads to a decline in fertility but also leads to a reduction in infant and child mortality as well (*Hobcraft, McDonald, and Rutstein, 1983; Trussell and Pebley, 1984*).

Theoretically, family planning can reduce infant and child mortality rates (*Hobcraft, 1987; Rinerhart, 1984; Trussell and Pebley, 1984*). Births that occur after a very short birth interval and births to either very young (*less than 20 years*) or relatively old women (*older than 30 years*), as well as at extreme parity (*first and greater than 7*), experience higher than average mortality risks. If the use of contraceptives leads to a reduction in the proportion of births with the higher risks involving birth intervals, birth order, and maternal age, then infant and child mortality rates would decline as the level of contraceptive prevalence rises. Thus family planning could reduce the number of infants born and improve chances for child survival. It should be noted here that these are only the effects of family planning on infant mortality rates as they operate through variation in family–building patterns, namely as a direct effect of family planning to child survival. However, other possible indirect effects of family planning to child survival should be considered. For example, an indirect effect of contraceptive use is the reduction in the number of births and hence the number of infants and the amount of health care they require. As a consequences of such a reduction in number of births, available resources could be used for fewer infants, which may increase the chance for child survival. Furthermore, the use of modern contraceptives may indirectly increase the use of other modern medicine and health services for a mother or her children because of the nature of integrated health services in many LDCs.

Bongaarts (*1987, 1988*) suggested that if only the direct effect of increased family planning on the distribution of births by maternal age, birth order, and birth interval is considered, then one cannot expect a significant reduction in infant mortality rates. He examined three groups of countries with low (*0–10 percent*), medium (*10–40 percent*), and high levels (*40–65 percent*) of contraceptive use, and found that in the transition from low to high contraceptive prevalence, the proportions of high–order birth and births to teenage mothers fall, as would be expected. However, he found that there is no substantial favorable effects on infant mortality rates. A previous study by Trussell and Pebley (*1984*) suggested a similar conclusion and was consistent with results from an experimental study in Matlab, which is a rural district in Bangladesh (*Philips et al., 1982*). In Matlab a highly successful family planning program has been able to increase contraceptive prevalence from less than 10 percent in 1976 to 34 percents in 1981, but over this time period only a small change in infant mortality rates was observed. This small change in infant mortality rates was probably due in large part to the introduction of maternal childhood services during that period observation.

The small impact of family planning on infant mortality is likely to be due to a shift in the composition of births by age, birth order, and birth interval (*Trussell, 1988*). That is, with increasing contraceptive prevalence, the proportion of births in some higher groups (*i.e., those of higher birth order*) declines while it rises in other groups (*i.e., first order*). Thus different effects of contraception (*positive or negative*) occur in various magnitudes and are largely offsetting, so that the overall impact is relatively small.

2.2.6 Food Supplement

Evidence suggests that nutritional supplements to children in LDCs improve nutritional status and decrease mortality, but not morbidity from infectious diseases such as diarrhea (*Beaton and Ghassemi, 1982; Ashworth and Feachem, 1986*). The best available information comes from Narangwal study in India (*Kielmann et al., 1978*). In this field study, supplemental feeding was provided for those children who exhibited symptoms of malnutrition according to the weight gain pattern. Children suffering from malnutrition were given food supplements until their weight increased to a normal level. If a child did not attend the feeding center, a home visit and "supervised feeding" were performed. On average, each child had 35 to 65 personal contacts per year. The frequent personal contact was a result of intensive supervision and backup support provided to the field worker who made the primary contacts with the family. The program success in improving nutritional status was also attributed to the continuing modification of overall program inputs in response to critical monitoring of program performance. Because of these extensive interventions, however, the effects can not be generalized to that of the much less controlled, less targeted community food distribution (*Beaton and Ghasemi, 1982; Mosley, 1985a*). Futhermore, although the food–supplementation program can actually reduce mortality and malnutrition, Beaton and Ghassemi (*1982*) concluded from several studies that the extent of effects of supplementary feeding on growth was "surprisingly small" for the benefit, primarily due to the fact that the food did not reach the target groups. Accordingly, many of LDCs policies do not implement a food supplement program, except for an occasional severely malnourished child found in the growth monitoring program. Even though in practice, this targeted intervention is not implemented except by parents who are advised to give more attention to their children.

2.2.7 Female Education

During the past two decades a considerable amount of information has become available from LDCs showing that maternal education has a strong and consistent association with child survival (*Caldwell, 1979, 1986; Cleland and Van-Ginneken, 1988; 1989; Grosse and Auffrey, 1989; Cochran, Leslie and O'Harra, 1982*) and nutritional status (*Mercer, 1987; Victoria et al., 1986*). In the past, most studies viewed maternal education as a proxy for general economic development or as a reflection of socioeconomic status of the family. It was only after Caldwell's paper from Nigeria concluded that maternal education is the most significant determinant of child mortality, that many investigators began to ask: "what is the direction of causation between education and health status?" Caldwell (*1979, 1986*) argued that maternal education cannot be employed as a proxy for general social and economic change, but rather must be examined as a force in its own right.

Empirical evidence for the association between maternal education and mortality has been demonstrated by many studies, mainly through the indirect measure of mortality (*Cohrane, O'Hara, and Leislie, 1982; Cleland and Van-Ginneken, 1988; 1989; Hobcraft, Mcdonald, Rutstein, 1985; Rutstein, 1984*). The inverse association between level of maternal education and child mortality is found in all major regions of LDCs. Even a modest exposure of the mother to formal education is associated with reduced risk of death in most contexts. It should be noted that the association is stronger in childhood than infancy (*Cochran, O'Harra, and Leislie, 1980; Rutstein, 1984*). The association between maternal education and nutritional status is also showing a similar pattern (*Mercer, 1987; Victoria, et al., 1986*).

There are many hypotheses to address the various mechanism and intervening factors that could explain how mother's education influences the health and survivorship of her children. Depending on the focus of the mechanism, maternal education can affect child survival through community level effects (*aggregate effects of education*), indirectly through other social economic factors (*i.e., a higher salary or income*), and directly through the proximate determinants. Whatever the route considered, there are two basic advantages from a formal education. These gains are a better knowledge and more resources in the household. We will discuss all possible routes below with some background on the empirical findings.

Maternal Education–Aggregate Effects

Maternal education may have an impact on child survival not only through the characteristic of the individual mother but also through the educational level of society as a whole (*Ware and Lamphere, 1984*). A better educated community will place greater demand on better health measures, clean water, and sanitation facilities, and be willing to pay for it (*O'Harra, 1980*). Case studies of Costa Rica and Kerala suggested that considerable contribution for the success of health programs went to an educated electorate that made the government more health-conscious (*Gonzales-Vega, 1985; Nag, 1985*). Evidence from Sri Lanka also showed that results of rising community aspirations had the effect of improving health awareness and thereby increasing investment in health at the household and public levels (*Meegama, 1986*). Quantitative findings on the utilization of family planning services have also been strongly associated with the level of maternal education at the aggregate level (*Entwistle, Mason, and Hermalin, 1986*)

Maternal Education and Other Social-economic Factors

It is reasonable to expect that maternal education plays a role expressed in other socioeconomic measures of the household. Increasing of education may be translated into increasing of availability of family resources, such as ability to pay health services, quality of food, better housing conditions, complete sanitation facilities, fuel supply, clothing and bedding. More importantly, educated mothers may be more effective than uneducated mothers at translating their family income and wealth into an improved nutritional status and survivorship for their children (*Caldwell, 1986*).

On reviewing many studies, Cleland and Ginneken (*1988; 1989*) reached the general conclusion that the economic advantages associated with education through income and wealth (*i.e., water and latrine facilities, clothing, housing quality, etc.*) probably account for about one–half of the overall education–mortality association. Furthermore, although interaction between education and income is theoretically plausible, general evidence for such interaction is surprisingly sparse. There are insufficient grounds to challenge the additive effect of maternal education to child survival.

Maternal Education and Proximate Determinants

Improvement in nutritional status and survivorship can be considered to be the consequences of enhanced knowledge and resources of women. The question is by what mechanism are the resources and knowledge gained from a formal education converted into better nutritional status and lower mortality? It has been suggested that formal education leads to better use of available health services, optimal child care and feeding practice, more hygienic household practice and personal habits, and the more "manifest demands" for health services. Caldwell (*1979*) has hypothesized that the education of women greatly changes the traditional balances of familial relationships, and tend to increase the woman's power in deciding the care of her children. Her educational level then can directly affect child survival by way of influencing her choices and increasing her skills in health care practices relate to proximate determinants: contraception, nutrition, hygiene, preventive and sickness treatment. For example, maternal education may enhance the health of the children through: 1) greater protection against infection, primarily through improved hygiene and sanitation; 2) reduced susceptibility to infection, primarily through immunization and improved nutrition; 3) enhanced recovery from infection, through more effective use of domestic or external health care; and 4) reduced risks of accident, through supervision. Mosley (*1985b*) termed this process as "a social synergism".

<u>Education and Maternal Factors:</u> The increase in infant deaths can be associated with too young or too old maternal age at delivery, first or high order birth, and short birth spacing (*Gray, 1984; Knodel Hermalin, 1984; Palloni, 1989*). Much evidence suggests that there is tendency for educated women to have a low risk of reproduction because of postponement of marriage and earlier cessation of childbearing, or even to space births at wider intervals. However, WFS data showed that the advantage conferred by education has little to do with the shift in reproductive behaviors (*Hobcraft, McDonald, and Rutstein, 1983; 1985*).

<u>Education and Nutrient Deficiency:</u> The evidence regarding association between maternal education on quantity or quality of food intake is weak. It is expected that women with higher education are

more efficient in household production of nutrition. For example, more educated women tend to be better informed about the contents of foods, the importance of nutrition, and nutritional options available from their own product or markets. Wolfe and Berhman, 1983 reported that such evidence was found in their study.

There is evidence regarding mortality and malnutrition associated with maternal education and breast-feeding practice (*Butz, Da Vanzo, and Habituate, 1982*). Breast-feeding for a long duration acts as a partial safeguard against infection and nutritional deficiency in infancy. The much weaker effect of maternal education at post–neonatal ages in childhood may indicate the great importance of breast–feeding for infant health. However, two conflicting trends may reverse or narrow the differential child survival between educated and non–educated women. First, the tendency for more educated mothers to stop breast–feeding earlier, and second, more educated mothers tend to work outside home. Both of these tendencies may operate against the observed education–mortality association. Participation in the labor force by mothers may reduce the time spent in child–rearing and domestic activities that attenuate the effects of maternal education. However, only a few studies support this finding, and in general most studies have failed to show such an effect (*Soekirman, 1983*), perhaps because the offsetting influence of the contribution of mother's earning to income or more contact with outside the household.

Education and Environmental and Hygienic Practice: As stated earlier, maternal education may enhance the ability and the desire to protect children's health and to exercise healthy hygienic practice and avoid unhealthy ones. The evidence for such practice at the individual level is a sparse. But analysis of the relationship between life expectancy and water supply and sanitation investments at the aggregate levels suggests the importance of education and environmental sanitation to health. Shuval et al. (*1981*) reported that the health impacts of water and sanitation programs were positively associated with the proportion of the adult population that were literate.

Education and Preventive and Curative Health Services: There is a complex relationship between maternal education and health practices in determining child survival. Education is not the sole factor determining the use of health services (*Andersen and Newman, 1975*). The use of health services is dependent on (*a*) the predisposition of the individual to use services, (*b*) the ability to secure services, and (*c*) the illness "level" and "type". Besides parental education, a particular type of employment and attitudes about "the Western modern medical paradigm" are more likely to determine the use health services, although these characteristics are not directly responsible for health services use.

Even though an individual may be predisposed to use modern health services, some means must be available for him or her to do so. A condition which permits a family to act on their needs regarding health services (*enabling factor*) is determined by family resources (*such as income, health insurance, or free services*), the number and type of health facilities/services available, and their surrounding community characteristics. Furthermore, even assuming the presence of predisposing and enabling conditions, the family must perceive that their child's illness requires the use of health services, which is the most immediate cause of health services utilization (*Anderson and Newman, 1975*). Nevertheless, a consistent finding supports the expectation that better educated women are more likely to use modern health services than less-educated mothers, which may become a central role in the explanation of mortality level.

Many studies concluded that maternal education affects infant and childhood mortality primarily through its association with better medical care at time of birth, both in the pre–and post–natal periods (*Caldwell, 1979; Jain, 1985; Nag, 1985; Tekce and Shorter, 1984*). The advantage conferred by education may be greater in setting where modern health services and facilities should be located (*Cleland and Van-Ginneken, 1988*). This is not to imply that the availability of health services and facilities alone determines health as much as their utilization; education plays a significant role in this case. In contrast to the previous view, some argued that in societies where services are widely available, personal characteristics, including education, become less important determinants of health (*Palloni, 1985; Rosenzweig and Schultz, 1982*). This may be consistent with the finding that strong family planning programs can reduce the socioeconomic differentials in contraceptive use and fertility (*Enstwistle, Mason, and Hermalin, 1986; 1988*).

The are many reasons why it is expected that educated mothers will use more of modern preventive and curative health services. Educated women may have a greater responsiveness to the illnesses of their children because of their awareness of the concepts of scientific medicine. It has been suggested that the most powerful influence of formal education is the transmission of concepts of modern scientific medicine (*Mosley and Chen, 1984*). With increasing understanding of this concept, women are more likely to accept or even to participate in health services (*Bonair, Rosenfield, and Tengvald, 1989*). Education is also increasing the possibility of women having greater social confidence at handling problems during the search for health services and a willingness to travel outside the home. In addition, the increase in social recognition because of her education will encourage her to seek a better health service in order to maintain "family prestige".

2.3 CHILD SURVIVAL INTERVENTIONS: The Indonesian Contexts

After having discussed how effective child survival technologies are and information about their use in populations, the next issue is to examine by what mechanisms such technology works. Certainly, the impacts of child survival interventions on mortality and nutritional status cannot be examined individually but rather should be integrated with both social and biological factors. The effects of these two factors should be viewed in common pathways. For example, besides focusing socioeconomic factors, in assessing a route of health intervention we should focus on all the proximate determinants proposed by Mosley and Chen (*1984*): maternal factor, nutrient deficiency, environmental condition, preventive or curative measures, and the child injuries factor. We shall examine each of these five proximate determinants and how they relate to child survival interventions, using the Indonesian data.

2.3.1 Maternal factors

Three maternal factors are commonly identified in child survival research: age of mother, parity, and birth interval (*Gray, 1984; Knodel and Hermalin, 1984; Mosley and Chen, 1984*). The last factor has repeatedly been shown to be very important in Indonesia (*Bracker and Santow, 1984; Hull and Gubhaju, 1986; Martin el al., 1983; Trussell,* *et al., 1985*) and other countries as well (*Fortney and Higgins, 1983; Hobcraft et al., 1985; Palloni and Millman, 1986; Palloni and Tielda, 1986; Palloni, 1989; Trussell and Pebley, 1984*). A short previous birth interval has deleterious effects upon a child's nutritional status and increase the risk of death.

Many publications of Indonesian data have frequently focused on the effects of spacing on the second (*younger*) child. However, it is obvious that where live–birth intervals are used, the length of the preceding interval is not independent of the survival of the first (*older*) child. Early cessation of lactation and an early return of ovulation and fecundability usually result in a shorter live–birth interval.

If a study does not specify whether the older of two sibling has died or survived to a specific age (*usually one or two years*), or alternatively, does not estimate the date of conception of second child (*index child*), the mechanisms by which birth intervals effect mortality will be obscure. Moreover, it has been suggested that shorter intervals and a higher risk of infant mortality seem to occur more often in Indonesian families with a history of child loss (*Bracker and Santow, 1984; Hull and Gubhaju, 1986*), although it is not clear whether the two events are causally related.

Mother's age at child birth also affects child survival. Young age reflects maternal immaturity, while old age is associated with increased likelihood of child death (*Gray, 1984; Knodel and Hermalin, 1984*). This factor is sometimes treated on a nonlinear scale to allow young (*i.e., younger than 18 years*) and very old (*over 40 years*) mothers to exhibit different mortality risks than mothers in the prime child-bearing years (*DaVanzo, 1984*). From another perspective, age may also be a measure of mother's experience with child care practices. As well as birth order, this factor may also reflect the likelihood that the child was wanted or unwanted. But birth order is often treated as a reflection of biological mechanisms and sometimes as a competition for family resources.

With regard to maternal characteristics, breast-feeding promotion, and family planning can indirectly be viewed as a program that may reduce mortality associated with short birth intervals and high parity (*Blacker, 1987; Fortney and Higgins, 1983; Hobcraft et al., 1983; Trussell and Pebley, 1984*). Although the Family Planning Program in Indonesia is coordinated by an independent board outside The Ministry of Health, the distribution of effective contraceptive methods is largely conducted by the staff of the Department of Health. This implies that the primary health center is partially responsible for the operational aspect of the program (*Ministry of Health of RI, 1983*). Indeed, together with local government staffs, primary health clinic leaders are asked to promote the program directly to the community (*Government of Indonesia and UNICEF, 1989*) . This integrated service is called a POSYANDU. Implicitly therefore, the health center is implementing a preventive program to reduce the adverse effects of maternal factors on a child survival through breast feeding promotion and family planning.

2.3.2 Environmental Exposure

There is no doubt that infectious diseases are the main causes of death in infants and children in Indonesia (*Budiarso et al., 1980; 1986*). It is also well known that there is a link between infection, malnutrition, and mortality in children. Environmental contamination, which refers to the transmission of infection agents to children and mother, is a major element in this causation. This involve transmission through ingestion of air, food and water, skin contact with soil and inanimate objects and exposure to insect vectors (*Mosley and Chen, 1984*).

Ideally, the levels of environmental contamination reflecting various routes of the spread of diseases can be measured directly by microbiological examination of air, water, food, skin, or vectors. However, it is almost impossible to use this method in a large population setting like Indonesia. As an alternative, some indirect physical indicators are commonly used to measure the degree of environmental contamination. For example, in the household one can measure the potential for air contamination and risk of contact with respiratory disease from the intensity of household crowding (*person per square room*). A potential for fecal contamination can be measured by the presence of latrines, and water contamination can be scaled by source of supply (*DaVanzo, 1984; Jain, 1985; Baltazar et al., 1988*). Type of household water and sanitation can measure the likelihood of exposure to gastrointestinal disease (*i.e., diarrhea, typhoid and parasitic diseases*) through contaminated water and soil.

In Indonesia, the improvement of water supply and sanitation services was a priority target of the three five–year development plans covering 1969-1984 period. However until 1974, little provision was made for rural water supplies in the government provincial budget, when funds were provided directly to local government (*Mathur, 1986*). Since then, the implementation of this project at the subdistrict level is supervised by a health center (*PUSKESMAS*). This task is one of many other health programs outside the direct preventive and curative activities of the PUSKESMAS (*Yahya, 1985*). It should be noted that promotion of better food sanitation and preparation are also implemented in the growth monitoring program. Using the same media, promotion of infant feeding supplements is also stressed. However, the impact on mortality or morbidity has never been reported.

2.3.3 Nutrient deficiency

Nutrient deficiency is a serious problem associated with child mortality in Indonesia. In field studies, nutrient deficiency is often measured with indirect techniques. Besides anthropometry, average protein and calorie consumption per individual has been used in Indonesia as an indicator of nutrient adequacy in the population (*CBS, 1987*). Vitamin and micronutrient deficiencies have also been reported in many studies, such as iron deficiencies in children and pregnant women, as well as iodine deficiency and vitamin A deficiency (*Budiarso et al, 1986*). Deficiency of vitamin A has been studied in its association with the mortality (*Sommer et al, 1986*). One report suggested that growth faltering is also associated with a risk of subsequent death (*Katz et al, 1989*), and this is supported by previous findings in other countries (*Chen, Chwodhury, and Huffman,1980; The Kasongo Project Team, 1983;1986; Kielmann and Cord, 1978; Sommer and Lowenstein, 1975; Trowbridge and Sommer, 1981*).

To overcome the problems of nutrient deficiencies of the population, the Indonesian government relies on The Family Nutrition Improvement Program or Usaha Perbaikan Gizi Keluarga (*UPGK*). This is an integrated, multi-faceted program of nutritional promotion and education which attempts to treat and prevent protein energy malnutrition (*PEM*), and iron and vitamin deficiencies (*mainly vitamin A*). Formerly this program was integrated with a Family Planning Program, but recently it has been coordinated by The Ministry of Health under the auspices of POSYANDU (*Government of Indonesia–UNICEF, 1989*). The POSYANDU uses the UPGK weighing post to integrate the delivery of five primary health services: 1) growth monitoring, 2) immunization, 3) maternal and child health, 4) family planning, and 5) diarrheal diseases control through ORT. Maternal child health here includes promotion of breast feeding, distribution of iron supplements for pregnant and lactating women, and distribution of iodine solution to endemic goitre areas. However, many POSYANDU still do not provide a complete range of services, and only child weighing, immunization and family planning are the most commonly available.

From a nutritional point of view, early weaning (*short breast feeding-interval*) has been attributed as a cause of malnutrition in children in Indonesia (*Kardjati, et al, 1978*). This is probably the case, where mother and child are living under low social–economic conditions and where food supplements are often inadequate. However, when children do receive adequate food supplements, weaning probably does not influence nutritional status (*Kusin, et al., 1985*).

The incidence of breast-feeding has declined during the last two decades, especially in urban areas. In Indonesia the decline was attributable to a wide range of factors, some of which were the increase the number of women working outside the home (*Soekirman, 1983*), the failure of most health personnel to give sufficient encouragement for breast-feeding during antenatal care, and the aggressive promotion of milk substitutes (*Kusin et al., 1985*). Accordingly, the extensive campaign to promote breast feeding has been a major objective of the Nutrition Improvement Program (*UPGK*) in Indonesia. This implies that a primary health center will be the coordinator at the sub-district level. However, local government staff and community organizations, especially a women's clubs (*PKK*), are responsible for the implementation of POSYANDU program. This latter program may be more successful compared to breast feeding promotion through a maternal child health clinics since this program can have a broader coverage. The same expectation applies to immunizations services through this program.

When women work outside the home, early weaning does not necessarily lead to malnutrition (*Soekirman, 1983*). It probably depends on the mother's motivation, i.e., whether working is aimed to improve their social level or is necessary for economic reasons. Among women who work merely for achieving the improvement of social status, adequate supplements for food and child care would not be a major constraint. The situation is different if woman is working hard outside the home, with the resulting energy losses and inadequate breast milk and food supplements (*Huffman and Lamphere, 1984*). Thus, in evaluating the impact of breast-feeding and child survival, it is necessary to take into account women's occupation and socioeconomic status (*Palloni and Millman, 1986*).

The duration of supplemented and unsupplemented breast feeding and type of supplemental or weaning food can be a causal link between malnutrition and infection (*Huffman and Lamphere, 1984*). In this case, the extent of supplementation or substitution may reflect the likelihood of ingestion of pathogens with breast–milk supplement or substitutes (*Surjono et al., 1980*). Important here is the quality of water sanitation. For example, Da Vanzo (*1984*) showed that interactions between supplementation practices and the water and sanitation variables must be considered in determining child mortality.

The Nutritional Improvement Program in Indonesia (*UPGK*) has also addressed the quality of food supplementation in children under 5 years old. The approach has been to demonstrate better food preparation rather than to give a food supplement. Monthly growth monitoring has become a main activity of UPGK. The health center staff are often used for this activity to promote better health, while stressing the importance of nutritional education as part of health education in general. With the current POSYANDU approach, a high dose of vitamin A is widely distributed due to the claims of its potential effectiveness in reducing mortality (*Sommer et al., 1986*).

In "a randomized controlled community trial" in 450 villages in North Sumatra, it was reported that semi annual distribution of vitamin A capsule (*60,000 microgram RE / UNICEF*) reduced childhood mortality by 34 percent over the course of one year (*Sommer et al., 1986*). The reduction in mortality was greatest among boys, which is consistent with their higher risk of xerophthalmia observed in the initial study. There was also reported from this study that the intervention improved children's growth (*West et al., 1988*). Mortality was mostly attributed to death from respiratory infection and diarrheal diseases. Since this trial was not a double–blind study, it has raised some concerns (*de L Costello, 1986; Gray, 1986; Martinez, Shekar, and Latham, 1986; Sommer and West, 1986*), especially about the comparability of intervention and control areas with the initial study. Obviously, it needs to be repeated in another set of randomized, double–blind control trials.

A second community study was conducted in West Java (Muhilal, et al., 1988). More than 11,000 children in ten communities were given vitamin A fortified monosodium glutamate (*MSG*), distributed unobtrusively through normal marketing channels. The study was a single–masked trial, but not a randomized trial by virtue of the type of intervention. Follow–up after one year reported that in addition to decreasing prevalence of vitamin A deficiency, there was an increase in linear growth, and improved hemoglobin levels, and a 31 percent decline mortality among children in the fortified versus control village. Again, because this study did not use completely randomized trials, attention has to be focused on whether such an effect can be expected in other parts of the country where the prevalence of vitamin A deficiency and other competing risks of death that limit child survival are different from the West Java and North Sumatra regions.

2.3.4 Personal Illness control

From an epidemiological perspective, mortality due to a specific disease can be avoided or reduced by implementing adequate personal illness control, such as immunization in child survival intervention. Indeed one may argue that child survival interventions are rather biased towards medical technologies to improve personal illness control. There are two broad categories of personal illness control: curative and preventive. The timing of interventions can be divided into three periods: prenatal, at delivery, and post–natal. This timing may be considered when assessing the route and impact of intervention on nutritional status and mortality. In household surveys, often malaria control, immunization, and antenatal care can be used as measures of preventive illness control. For curative measures, the type of therapy taken for specific conditions and the type of provider are used as indicators. This information is available from a previous household health survey (*Budiarso et al., 1980, 1986*), but its relationship to infant and child mortality has not yet been published.

In selecting indicators for personal illness control, one major issue arises, that is, the effectiveness of therapeutic or preventive illness control measures at the community level. It is obvious that the demographic impact of personal illness control activities is strongly influenced by its community level effectiveness. At least five factors are responsible for the degree of its effectiveness. These are: 1) coverage, 2) efficacy of a specific prevention or curative controls, 3) provider's compliance to the programs being implemented, 4) mother and child compliance to a therapeutic and prevention schedule, and finally, 5) diagnostic accuracy for a specific disease being treated or prevented (*Bennett et al., 1990*). Thus ideally, one can select indicators relevant to these five factors. However, most population surveys only cover factors of coverage, and the kind and number of health providers. Therefore it is possible that the implications of personal illness control used in the model will not explain much of the variation in child survival. Futhermore, since compliance to curative and prevention schedules is largely determined by individual characteristics, the educational level will be a critical factor for the utilization of preventive and curative controls (*Chernichovsky and Mesook, 1986*).

According to government reports, although most under–five deaths (*except neonatal tetanus*) result from the cumulative effects of a broad range of risk factors such as multiple infections, undernutrition, illiteracy, and poverty, it is estimated that at least 150,000 deaths could be prevented annually by preventive illness

control through vaccination programs (*Ministry of Health, 1983*). The Indonesian Expanded Immunization Program was initiated in 1977 and has been expanded in a planned and phased manner. By the year 1985 immunization had been accepted as a key element and a very cost–effective component of child survival interventions. A recent evaluation indicated that these trends in coverage are increasing (*Foster, 1987*), and provided there is no decrease in effort or budgeting support, this trend will continue. By the end of the fourth five–year plan (*1989*) it is targeted that all children under age one will have access to immunization and that 65 percent of all children will be fully immunized by their first birth day.[3] It is expected that this preventive illness control will bring down the infant and child mortality in Indonesia, albeit up to now mortality impacts have only been demonstrated in a few studies (*Arnold, Soewarso, and Karyadi, 1986; Solter et al., 1986*).

Diarrheal disease is still one of the many causes of deaths in children under five. Lerman et al. (*1984*) reported that diarrhea rates average 2.9 episodes per child per year, with a range of 2.4 to 3.6. Use of oral rehydration therapy (*ORT*) for children with diarrhea ranges from 32 to 88 percent of episodes, predominantly in the form of ORS. The use of ORT did not reduce hospitalization rates from diarrhea, or the substantial consumption of antibiotics and a wide variety of other diarrheal medications. But, there is no information on whether case fatality rates in the community can be reduced by ORT. The areas that have achieved the highest level of ORT use seem to have accomplished this by encouraging the use of ORT either through private providers or village health workers and for self care, but not by expanding ORT treatment at the health center.

[3]Access was defined as not having to travel more than 5 kilometers to obtain the immunization services. Being fully immunized was defined as having received one dose of BCG, three doses of DPT and polio, and one dose of measles vaccine.

2.3.5 Child Injuries

Even though it suspected of being an important factor for child survival, publications relating to child injuries are almost absent from the literature in the developing world. The data that is available is prone to bias due to the problem of underreporting, even though a cause of death due to injuries can be collected easily, since it is often seen as a tragic event in population. Considering that the incidence of child injuries in a population is relatively low compared to infectious diseases, it would be difficult to include child injury factors in our study.

Chapter 3

ANALYTICAL FRAMEWORK – STATISTICAL MODEL

3.1 INTRODUCTION

This chapter starts with a presentation of the analytical framework for the assessment of the health status index. We will use this framework to develop statistical models using child survival interventions as explanatory variables and either mortality or nutritional status alone as the dependent variable. To test our hypothesis that the new indicator of child health status is more useful in evaluation of child survival interventions, we compare these statistical models (nutritional status and mortality as outcome variables) to a model using the index of health status as the dependent variable. Because our models have many difference outcome variables, appropriate statistical analyses should consider levels of measurement of these outcomes (*i.e., a continuous or an ordinal scale*) and the issue of a censoring observation.[1] However, regardless of which outcome is considered, the theoretical framework will be the same, so that variables selected should be substantively meaningful and comparable across models. This will al-

[1]Censoring observations occur when exact observations (i.e., lifetimes) are known for only a portion of the the individuals under study and the remainder of observations are known only to exceed certain values.

low us to compare the consistency of the parameter estimates (slopes) of explanatory variables across models.

Our model will focus on the main child survival interventions. The model of child survival intervention effects draws on the conceptual framework developed by Mosley and Chen (1984), which groups mortality and nutritional status determinants into blocks of variables that have an explicit causal ordering. According to this framework, socioeconomic variables, including child survival intervention, must affect child health through one or more of five sets of proximate determinants, some of which are intervention indicators that can be measured directly (*such as child immunization status*). This chapter describes the details of such order–relationships from an analytical point of view.

We will use multivariable techniques to deal with survival data, as well as a statistical technique for an ordinal dependent variable. The former has been extensively used in a recent years, but the latter is not widely used in the literature. Following the discussion on the analytical framework, this chapter provides an overview of these two techniques with an emphasis on the ordinal data. We only describe the proportional odds model, but other models are well explained in McCullagh and Nelder (*1989*). Descriptions use only broad notation since this technique will be used in both the nutritional status and "health index status" models. Details of the variables in the models will be discussed in chapters 6, 7, and 8 along with the results of parameter estimations.

3.2 ANALYTICAL FRAMEWORK

Figure 3.1. is a complex scheme which simplifies the association between variables collected in our study. Details of the associations between variables have already been discussed in the literature review in previous chapter. Given the multiplicity of variables, it is impossible to choose a single model that will be able to test of our hypotheses. Therefore, we will simplify our analysis. Some basic determinants that can be examined with the framework are given below.

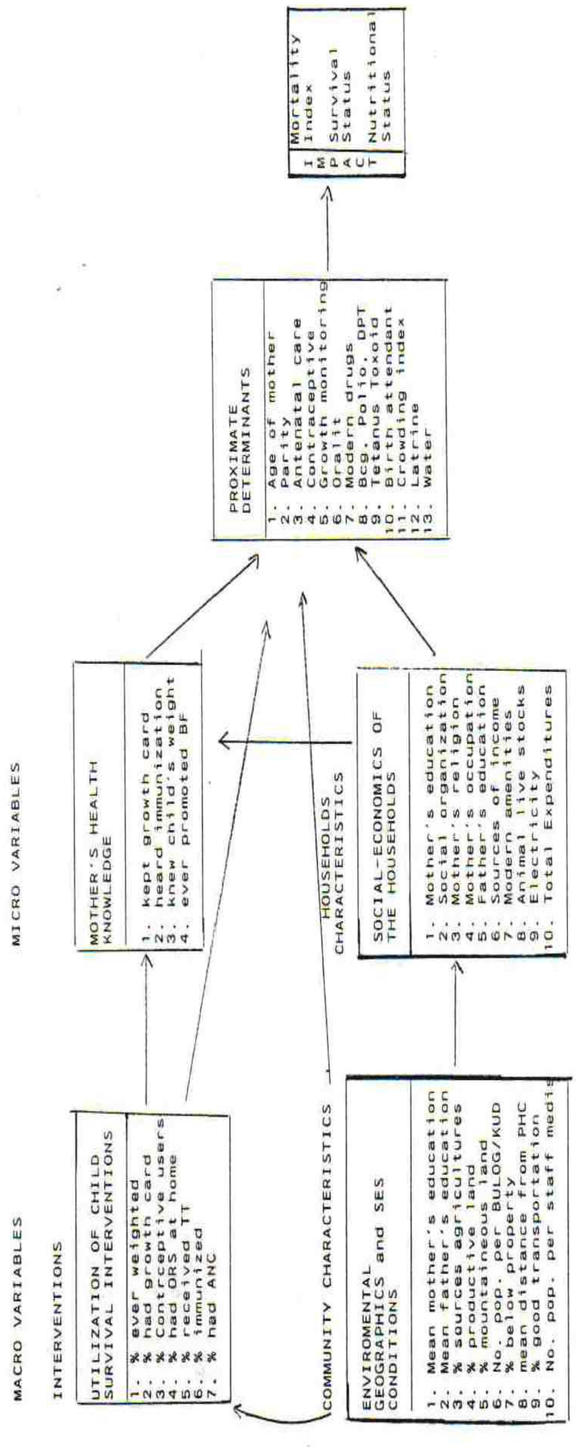
3.2.1 Determinants of Child Health Status

1. Mother's participation in a Family Nutrition Improvement Program (*UPGK*), as measured by the adoption of growth monitoring, increases the probability of having a better child health status after parents' education, occupation, income, availability of health services, strength of the child survival program, and level of community development have been taken into account.

2. The association between the adoption of growth monitoring and a better child health status is seen mainly through the mechanisms of increasing the mother's health knowledge and the utilization of child survival technologies, especially immunization and contraception.

3. The adoption of oral rehydration therapy (*ORT*), as measured by the availability of oral rehydration salt (*ORS*) within a household, increases the probability of having a better child health status after sources or depots of ORT have been accounted for, such as the availability of health services.

Figure 3.1: Diagram Conceptual Framework of The Models



4. Factors associated with the adoption of ORT (more likely to occur among those who live in a better household environmental condition, who preventive and curative measures, and who have a higher socioeconomic status) have a stronger association with child health status than the marginal impact of adoption of the ORT program.

5. The apparent impact of utilization of immunization on child health status is higher than its net impact, because its impact is confounded by the utilization of other modern health services, such as an antenatal care and a contraceptive method.

3.2.2 Operational Definitions

To clarify our conceptual framework, we will limit our operational definitions to the concepts previously described. Although these definitions have a narrow interpretation here, the terms used are comparable in other settings.

1. Outcome Variables–The impacts of intervention. We define the impacts associated with child survival interventions in terms of the mortality and the nutritional status among children born in the past 5 years. These outcomes are measured by a cross–sectional survey of the population. Four different outcomes are considered:

   (a) the mortality index for mothers, derived from information on children ever born and children surviving;

   (b) the nutritional status of children under 5 years

   (c) the survival status of children born in the past 5 years; and

   (d) a composite health status index.

Scales of measurement for these four outcomes (dependent variables) are interval, ordinal, dichotomies, and ordinal respectively. Furthermore, for survival status we are interested in the distribution of survival times rather than just a dead or alive at the time of survey. More importantly, we create a new "a health status index" which combines growth faltering and mortality into a single ordinal scale. This is done by using a classification of nutritional status similar to Gomez (*1955*) which includes three grades of malnutrition (I, II, III) (*the details of this classification are presented in chapter 7*), and assigning a child death at level or grade IV. Thus, including normal children as Grade 0, this index should be viewed as having an ordinal scale with 5 categories/levels.

2. <u>The adoption of growth monitoring</u>. The adoption of growth monitoring is defined as the availability of a growth card within the household, or history of having such a growth card, as the indicator of mother's participation in the *UPGK* for her children. It is expected that participants in *UPGK* have having children with a better health status than non-participants of the program.

3. <u>Adoption of oral rehydration solution</u>. The adoption of oral rehydration solution use is measured by the availability of ORS packages within the household. Because of our interest in examining the ORT intervention program, the use of homemade ORS would be a useful indicator. However, because of the difficulties involved in measuring the use of homemade ORS, this information was not collected in our survey. When "availability of health services" is included in the model, that indicator can serve as a proxy for ORT program effort. It is expected that households with ORS at home

can be associated with better prevention and treatment of diarrheal diseases. Because this disease is the main cause of morbidity and mortality, we expect that children in houses with ORS packages are likely to have a good health status.

4. Utilization of immunization. This concept measures the utilization of BCG, DPT, Polio, and TT during pregnancy. The completeness of these immunizations according the respective schedules is distinguished by the degree of utilization. By preventing several major childhood diseases, immunizations are expected to prevent child deaths or growth faltering as a direct consequence of illness.

5. The use of modern health services. The use of modern family planning methods, such as intrauterine devices, pill, condom, or sterilization, is an indicator of the use of modern health services, especially considering the heavy clinic–based family planning program in this area. If a woman has ever used a contraceptive method, she is likely to have visited the place of the modern health services where curative service for her children is available. Other uses of modern health services include the use of immunizations, antenatal care, and the use of professional birth attendants. We found that information about receiving TT injection during pregnancy proved to be more convincing than the response to the question on whether the woman was ever or never visited a health provider during pregnancy. So this information will be considered as a proxy for receiving both antenatal care and TT immunization during pregnancy. All of these are expected to have a positive association with a better health status.

6. Health knowledge. To measure mother's health knowledge, we

use a simple variable based on the mother's answer as to whether she never or ever before heard the word "immunization". Actually, we asked many questions about immunization knowledge, but this simple question captures most of the variance in the descriptive analysis. So we decided to use the simple question: ever or never heard the word "immunization". This kind of information serves as an indicator of the overall success of health promotion, which may be given during growth monitoring session or while attending antenatal clinics, meetings of women's clubs (*PKK*), etc. When women are more aware about health matters, they are generally assumed to use modern health services and live with better health behaviors. So it is reasonable to expect that their children will have a good health status.

7. Better environmental conditions. The availability of pipe water, latrine, and less crowded households are indicators of better environmental conditions. The better environment is expected to result in a better child health status, because it is expected to reduce the probability of sickness associated with a poor environmental sanitation.

8. Socioeconomic status. At the individual level, socioeconomic status can be measured from income, occupation, and wealth. At the community level, it can be measured from the availability of school facilities, food storage, electricity, land and road conditions, and urban–rural status. The complexities in analyzing the association between socioeconomic status with health status have been discussed in the previous chapter. In principle, it is expected that the higher the socioeconomic status of a household or their living

areas, the better the health status of their children.

9. Program strength. The strength of the child survival program at the community level is measured by the percentage of mothers or of children under five years of age who have utilized one or more of the main child survival interventions (*GOBI*), as well as by the population (in hundred thousands) per cadre or per health professional. It is expected that a strong health program at the community level will be associated with the good health status of the children within its coverage area.

10. Opportunity to utilize modern health services. The utilization of health services is influenced by the availability and accessibility of services. When services are available and accessible, the chance of utilization should be better, although the demand for certain services will also determine such utilization. We use distance from village to health care facilities as a measure of availability of health care facilities. The greater the distance from home to health care facilities, the more likely it is that children would not receive any treatment during illness, therefore increasing the probability of dying or growth faltering.

11. Level of community development. The level of community development can be measured based on the availability of school facilities, government food storage (*BULOG*), electricity, road conditions, and social organizations within a village. Among these variables, the percentage of villages within PHC with asphalt roads will be used as an indicator of regional or community development. More developed communities are presumably associated with a good of health status of children in this community.

Because of hierarchial effects postulated in our framework, our first approach to data analysis is performed according to its levels (*i.e., at the macro/aggregate level, the characteristics of PHC will be associated with the prevalence rate of growth faltering at PHC level*). This approach is then followed by an analysis across levels (*i.e., the probability of having growth faltering of each child will be associated with the characteristics of each child (*micro level*) and PHC (*macro level*)*) in the one model.

In the multivariable analysis, we have distinguished five sets of explanatory variables:

1. Child and maternal biological factors (Biologic): child's age, mother's age, and birth order.

2. Child survival interventions (Intervention): *UPGK* participation, availability of ORS, antenatal care received (tetanus toxoid), completed immunization, and use of contraceptive.

3. Mother's education and Health knowledge (Mother): mother's education and knowledge of immunization.

4. Family characteristics (Family): availability of flush latrine, father's occupation, household income/expenditures.

5. Health center and community factors measured at PHC level (Macro): proportion of immunized children within PHC, proportion of MWRA who ever used modern contraceptive methods, distance from the village to health center facilities in kilometers, and proportion of village area having asphalt road.

Drawing on the Mosley–Chen framework, in the multivariable analysis we can use seven equations to structure our assessment of the effects of these five sets of variables:

1. Outcome=$\mathcal{F}$(Biologic, Intervention)
2. Outcome=$\mathcal{F}$(Biologic, Mother)
3. Outcome=$\mathcal{F}$(Biologic, Family)
4. Outcome=$\mathcal{F}$(Biologic, Macro)
5. Outcome=$\mathcal{F}$(Biologic, Intervention, Mother)
6. Outcome=$\mathcal{F}$(Biologic, Intervention, Mother, Family)
7. Outcome=$\mathcal{F}$(Biologic, Intervention, Mother, Family, Macro)

In all equations the biological factors are included in the model, since it is well known that these variables always effect the outcome variable (control variable). From equation (1) we obtain estimates on effects of intervention adjusted to biological factors, while from equations (2), (3) and (4) we obtain estimates on effects of mother, family, or macro factors adjusted for biological factors. Comparison between equations (5) and (1) indicates the extent to which the intervention effects are due to associations of intervention with other maternal characteristics. On the other hand, one may compare equations (2) and (5) to see how maternal effects are associated with the intervention variable. However, our main interest is an intervention effect, so that comparison of equations (5) and (1) would be more useful in answering questions related to real intervention effects. Similarly, comparison of equations (6) and (5), and equations (7) and (6) are intended to examine the extent to which the intervention effects are confounded by the family and macro variables respectively.

Regardless of the magnitude and size of birth order or age effects, these will be included in the model as control variables. In general, however, the magnitude of change in the parameter estimates for variables of interest (intervention) and the improvement of the coefficient of variation when a new variable is included will be used to justify the importance of a new variable in the model (*significance of* R^2 *improvement or Likelihood Ratio test and parameter estimates or maximum likelihood estimates*) (*Aitkin, et al., 1989; Cox and Snell, 1989; Lawless, 1982; Lawless and Singhal, 1987a*). All models will be assessed using this approach, regardless of the statistical techniques used. In addition, when it is appropriate, the relative risk estimates will be used as the basis for justification of the practical importance of each explanatory effect.

3.3 STATISTICAL MODELS OF ORDINAL DATA

3.3.1 Ordinal Dependent Variable

In most cases, the ordinal dependent variable is viewed as a monotonic transformation of interval variables (*Anderson and Philips, 1981; Anderson, 1984; Armstrong, 1989; Ashby et al., 1986; Engel, 1988; McCullagh, 1980; McCullagh and Nelder, 1989*). It is assumed that this ordinal response is related to a continuous or interval–scaled underlying variable, say Z, usually being nonobservable. For example, an anthropometric measure may place child in one of a number of categories of nutritional status, such as, ‘a normal’, ‘first degree’, ‘second degree’, or ‘third degree of malnutrition’. An underlying continuous variable denoting child’s degree of nutritional status (*usually presented in Z–scores*) is mapped into categories that are ordered but are separated by unknown distances. In this case, the underlying variable is often treated as continuous but might be better viewed as an ordinal scale, especially when considering our newly defined “index of health status”. More precisely, by assigning a child death in a rank below third–degree malnutrition, we can have a new health status index as an ordinal scale with five categories. It is also assumed that this ordinal variable can be related to a continuous underlying variable, “health status” which is non–observable (*a latent variable*).

The main interest of analysis does not lie in the ad hoc response categories (the observed categorical variable) but rather is in the variable Z (*nutritional or health status*) and the distribution and information about Z that is obtained via the categorical ordinal response. In many practical applications, the choice and definition of response categories is either arbitrary or subjective. It is essential, therefore, to obtain valid conclusions so that our results should not be affected by the number or choice of response categories. This implies that if a new category is formed by combining adjacent categories of the original scale, the form of conclusions should not be affected (*Agresti, 1984; McCullagh and Nelder, 1989*), even though it will normally change the estimate of effect and the attained significance level.

The measurement model of ordinal dependent variables can be formally stated as follows. Let Z denote either an observed (*i.e., Z–scores of weight for age given sex*) or an unobserved continuous variable (*i.e., health status level*) with $-\infty < Z < \infty$. We define $\theta_0, \theta_1, \ldots, \theta_{J-1}, \theta_J$ to denote cut of points in the distribution of Z, where $\theta_0 = -\infty$ and $\theta_J = \infty$ and $\theta_1 \leq \theta_2 \leq \ldots, \theta_{J-1}, \theta_J$ (See figure 3.2). Let Y be an ordinal response such that the relationship between the response variable Y and the variable Z can be expressed as follows:

$Y = j$ if $\theta_{j-1} \leq Z < \theta_j$; $j = 1, 2 \ldots J$,

where as defined earlier, $\theta_0 = -\infty$ and $\theta_J = \infty$. Further, we assume that Z has a certain distribution and that its mean and variance are known (*For example when Z has a normal distribution, then it has a mean of zero and a variance of one*).

The relationship between Z and Y can be further understood as follows. Consider the likelihood of obtaining a particular value of Z and probability that Y takes on a specific value (see figure 3.2). If Z follows a probability of normal distribution (*it could be a non–normal distribution*) with a density function $f(Z)$ and cumulative density function $\mathcal{F}(Z)$, then the probability that $Y = j$ is defined by the area under the density curve $f(Z)$ between θ_{j-1} and θ_j. This may be expressed as:

$$\pi_j = P(Y = j) = \int_{\theta_{j-1}}^{\theta_j} f(Z)dz \tag{3.1}$$

or

$$\pi_j = P(Y = j) = \mathcal{F}(\theta_j) - \mathcal{F}(\theta_{j-1}) \tag{3.2}$$

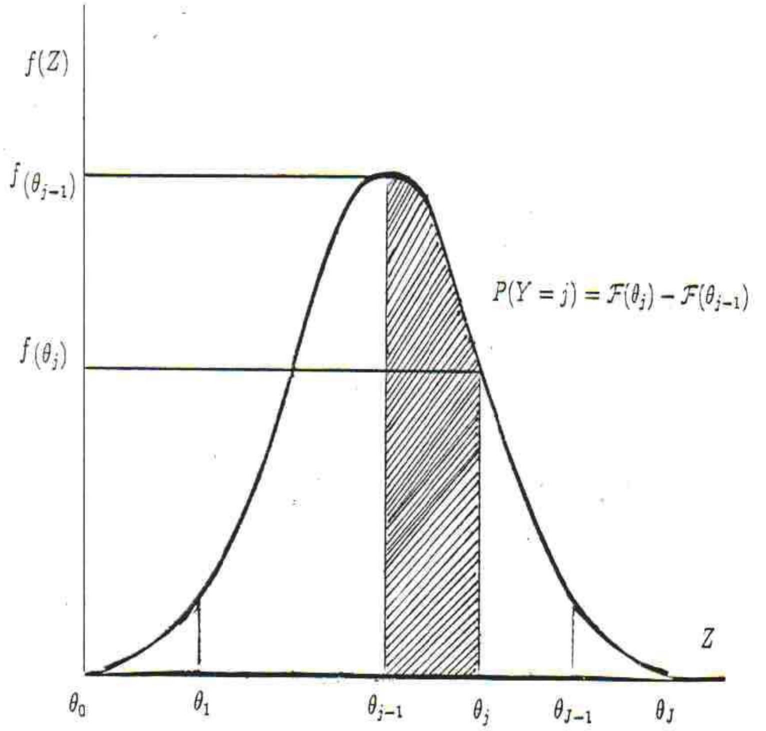
where $\mathcal{F}(\theta_J) = 1$ and $\mathcal{F}(\theta_0) = 0$.

For a sample of children in which Y is observed, one can estimate the "cut-points" or "thresholds" θ_j as

$$\hat{\theta}_j = \mathcal{F}^{-1}(p_j), \tag{3.3}$$

where p_j is the proportion of observed cases for which $Y < j$, and $\mathcal{F}^{-1}$ is the inverse of the cumulative density function of Z. Given estimates of the θ_j, it is also possible to estimate the mean of Z for observation within each interval. If Z follows a standardized normal distribution, then the mean of Z for the observation for which $Y = j$ is

Figure 3.2: RELATIONSHIPS AMONG LATENT CONTINUES VARIABLE (Z), OBSERVED ORDINAL VARIABLE (Y), AND THRESHOLDS (θ_j)



$$Z_{\theta_j,\theta_{j-1}} = \frac{\phi(\theta_{j-1}) - \phi(\theta_j)}{\Phi(\theta_j) - \Phi(\theta_{j-1})} \tag{3.4}$$

where ϕ is the standardized normal probability density function and Φ is the cumulative standardized density function (*Johnson and Kotz, 1970*).

3.3.2 Model Specification

To define our ordinal models, it is assumed that we have a set of N which is an independent observation of response and explanatory variables. The ith individual for $i = 1, .., N$ consists of a vector of explanatory variables with p components, say $\boldsymbol{x}_i = (x_{i1}, \ldots, x_{ip})^\top$, and a response Y_i belonging to one of J distinct categories $j,\ j = 1, \ldots, J$, of the response variable. Given $\boldsymbol{x}_i$, the probability of a response $Y_i = j$ will be denoted by $\pi_j(\boldsymbol{x}_i)$. It is assumed that Y_i observations are independent. Here if we define $n_j(x)$ as the total number observed in category j, taking into account all observations i for which $Y_i = j$ and for which the vector of explanatory variable $\boldsymbol{x}_i$ is x. Thus for a fixed value x of the vector of explanatory variable, the vector $[n_1(x), \ldots, n_J(x)]$ of numbers of classified response has a multinomial distribution with the probability vector $[\pi_1(x), \ldots, \pi_J(x)]$.

Let us define

$$\gamma_j = \sum_{k=1}^{j} \pi_k(\boldsymbol{x}_i) \tag{3.5}$$

for the cumulative sum of probabilities. Several models can be defined with respect to that sum. Models for ordinal data differ in the way relationship between explanatory variables $\boldsymbol{x}_i$ and this sum probability

$\pi_j(\boldsymbol{x}_i)$. For proportional odds (*logistic model*), which is considered here, we specify that

$$\gamma_j(\boldsymbol{x}_i) = \frac{\exp(\theta_j - \boldsymbol{\beta}^\top \boldsymbol{x}_i)}{1 + \exp(\theta_j - \boldsymbol{\beta}^\top \boldsymbol{x}_i)} \tag{3.6}$$

and that this is the cumulative distribution function of variable Z at the value of θ_j, where Z has the logistic distribution with unit scale and parameter location $\boldsymbol{\beta}^\top \boldsymbol{x}_i$. It should be noted that $\theta_1, \leq, \ldots, \leq \theta_J$ and $\boldsymbol{\beta}$ is a parameter vector with p components not depending on j.

Taking the natural logarithm on both sides, we may write equation 3.6 as

$$\log\left[\frac{\gamma_j(\boldsymbol{x}_i)}{1 - \gamma_j(\boldsymbol{x}_i)}\right] = \theta_j - \boldsymbol{\beta}^\top \boldsymbol{x}_i \tag{3.7}$$

where $i = 1, \ldots, N$, and $j = 1, \ldots, J - 1$, which is a linear model for the log odds. Note that the difference between corresponding cummulative logits is independent of category involved. McCullagh (*1980*) called this model a proportional odds. If the response variable has only two categories, this model reduces to a binary logistic regression. Further, equation 3.7 can be generalized as

$$\phi(\gamma_j(\boldsymbol{x}_i)) = \theta_j - \boldsymbol{\beta}^\top \boldsymbol{x}_i, \tag{3.8}$$

where $i = 1, \ldots, N$ $j = 1, \ldots, J - 1$.

Here $\boldsymbol{\beta}$ is a parameter vector and ϕ is *link function*, such as the complementary log–log (*McCullagh and Nelder, 1989*). It should be noted that the negative sign in equations 3.6, 3.7, and 3.8 is a convention ensuring that a large value for $\boldsymbol{\beta}^\top \boldsymbol{x}_i$ leads to an increased probability for the higher numbered categories. To specify "link function", it is necessary to select a probability distribution for Z, or equivalently for the error terms. If the probability that Y takes on successively higher values rises (or falls) slowly at small values of $\boldsymbol{x}_i$, more rapidly for intermediate values of $\boldsymbol{x}_i$, and more slowly again at large value of $\boldsymbol{x}_i$, then either the logistic or the normal distribution is appropriate for error terms. The former distribution yields the ordered logit model (*a proportional odds*), the latter the probit model. If OLS, in which the observed variable Z is replaced by the observed ordinal variable Y in the regression model, it assumes that the probability that Y will take on successively higher values rises (falls) at a constant rate over the entire range of $\boldsymbol{x}_i$. Thus OLS should not be used in the health status assessment since such an assumption will likely be violated.

3.3.3 Parameter Interpretation and Estimation

Parameters are estimated by the maximum likelihood method and tested by likelihood ratio statistics. In practice, one seeks estimates for the shape parameter(s) $\boldsymbol{\beta}^\top$ (*slope*) and threshold parameters γ_j(*intercept*). The former denotes the effect of unit change in the explanatory variable $\boldsymbol{x}_i$ on the unobserved variable Z. The latter provides information on the distribution of the ordered response variable, such as whether the categories of the variable are equally spaced on the logit scale. Since the odds for event $Y = j$ are calculated by the ratio $\gamma_j(\boldsymbol{x}_i)/(1 - \gamma_j(\boldsymbol{x}_i)$, where $\gamma_j = \sum_{k=1}^{j} \pi_k(\boldsymbol{x}_i)$, the interpretation of the proportional odds model is identical to the linear logistic regression model:

$$\log\left[\frac{\gamma_j(\boldsymbol{x}_i)}{1 - \gamma_j(\boldsymbol{x}_i)}\right] = \theta_j - \boldsymbol{\beta}^\top \boldsymbol{x}_i, \tag{3.9}$$

where θ_j is equal to log odds that $Y_i \leq j$, given covariate values $\boldsymbol{x}_i$, so that the difference between corresponding cumulative logits is independent of the categories involved. For example, the odds of the event

$Y_i \leq j$ at x_{i1} versus x_{i2} is

$$\frac{\gamma_j(x_{i1})/(1-\gamma_j(x_{i1}))}{\gamma_j(x_{i2})/(1-\gamma_j(x_{i2}))} = \exp\left(-\boldsymbol{\beta}^{\top}(x_{i1}-x_{i2})\right), \tag{3.10}$$

which is independent of the choice category j. If x_{ip} is an indicator variable for two different groups, G_1 and G_2, this equation may be written as

$$\left[Odds\frac{(Y_i \leq j|G_1)}{(Y_i \leq j|G_2)}\right] = \exp(-\Delta), \tag{3.11}$$

where $j = 1, \ldots, k-1$, and Δ measures the group effect. The quantity $\exp(-\Delta)$ is called <u>an estimated relative risk or odds ratio</u>. Here the negative sign is a convention, as discussed earlier, for ensuring that large values of $\boldsymbol{\beta}^{\top}$ lead to an increase probability in the higher numbered categories j. Notice in particular that when there are only two response categories, equation 3.9 is equivalent to the usual binary logistic regression (*Agresti, 1984; Cox, 1989; Hosmer and Lemeshow, 1989*).

No matter which "link function" (probit, logit, or log-log link) for $\Pr(Y_i = j|\boldsymbol{x}_i)$ is used, estimates are required for the $p+k-1$ parameters: $\theta^{\top} = (\theta_1, \ldots, \theta_{k-1})$ and $\boldsymbol{\beta}^{\top} = (\boldsymbol{\beta}_1, \ldots, \boldsymbol{\beta}_p)$. If the unobserved dependent variable Z has a conditional expectation, given explanatory variable(s) $E(Z|\boldsymbol{x}_i) = \boldsymbol{\beta}^{\top}\boldsymbol{x}_i$ and a variance of one, then measurement model 3.2 can be modified to give probability that ith individual takes value j on the ordinal dependent variable as

$$p(Y_i = j \mid \boldsymbol{x}_i) = \mathcal{F}(\theta_j - \boldsymbol{\beta}\boldsymbol{x}_i) - \mathcal{F}(\theta_{j-1} - \boldsymbol{\beta}\boldsymbol{x}_i) \tag{3.12}$$

where $\mathcal{F}(\theta_0 - \boldsymbol{\beta}\boldsymbol{x}_i) = 0$ and $\mathcal{F}(\theta_J - \boldsymbol{\beta}\boldsymbol{x}_i) = 1$ because $\theta_0 = -\infty$ and $\theta_J = +\infty$ (*Winship and Mare, 1984*). Since our model is *an ordered* *logit*, then $\mathcal{F}$ is the cumulative logistic function. If model is *an ordered probit*, then $\mathcal{F}$ is the cumulative standard density function. The quantity of 3.12 for each individual are combined to form the sample likelihood. The likelihood function from independent observations that correspond to observed ordinal variable $(Y_i, \boldsymbol{x}_i)$ $i = 1, \ldots, N$ is

$$L(\theta, \boldsymbol{\beta}) = \prod_{i=1}^{N} \prod_{j=1}^{k} [\gamma_j(\boldsymbol{x}_i) - \gamma_{j-1}(\boldsymbol{x}_i)]^{\delta_{ij}} \tag{3.13}$$

where $\gamma_0(\boldsymbol{x}_i)$ is defined as 0, and $\gamma_k(\boldsymbol{x}_i) = 1$. For ith individual here $\delta_{ij} = 1$ if $Y_i = j$, and zero (0) otherwise. Maximum likelihood estimation consists of finding value for $\boldsymbol{\beta}$ and θ in equation 3.13, so that $L(\theta, \boldsymbol{\beta})$ is as large as possible. The estimates of θ and $\boldsymbol{\beta}$ are usually given by maximizing $L(\theta, \boldsymbol{\beta})$ using a Newton Raphson algorithm. A modified approach is given by Lawless and Singhal (*1987a, 1987b*) to reduce computing time when a sample is very large. The details of this approach are beyond this discussion.

3.3.4 Model Selection and Goodness of Fit

A formal testing of goodness of fit is performed by Pearson's χ^2 or by likelihood ratio statistics(LR). If our model contains some adjustable parameters (*i.e., there is a choice as to the number of parameters included in the model*), we can obtain "a good model" by selecting the values of parameters that maximize the log likelihood. The method of estimating parameters contained in a model is called the method of the maximum likelihood. The estimator $(\hat{\theta}, \hat{\boldsymbol{\beta}})$ derived by this method is called the maximum likelihood estimator (MLE). The model specified by the MLE is the maximum likelihood model. The value of the likelihood of the maximum likelihood model is called the maximum log likelihood $L(\theta, \boldsymbol{\beta})$, or sometimes refereed to as a log likelihood only.

Indeed we will use this term often.

The goodness of values of parameters of a specific model can be measured by the expected log likelihood, which is to say, the larger the expected log likelihood the better the values of parameters. The log likelihood can be regarded as an estimator of the expected log likelihood. Sometimes one uses the term "the mean expected log likelihood", which is defined as the mean of the expected log likelihood with respect to the data $\boldsymbol{x}_i$, in the maximum likelihood model. This mean expected log likelihood can be regarded as a measure for the goodness of fit of a model.

The guiding principle with a generalized linear model is to compare the observed values of the response variable to the predicted values obtained from the model with and without the explanatory variables in question, based on mean expected log likelihood. Conceptually, however, one should think that an observed value of the response variable is being compared (predicted) to a saturated model (*model which contains as many parameters as there are data points*).

The comparison of observed to predicted values is based on the –2 times maximum log likelihood ratio that follows a χ^2 distribution. Such a test is called the likelihood ratio test, which has the following expression:

$$D = -2\left[\frac{max.\ log\ likelihood\ current\ model}{max.\ log\ likelihood\ saturated\ model}\right] \tag{3.14}$$

(Note that the quantity inside the large brackets in the expression above is called a likelihood ratio.) The value of D in GLIM (*General Linear Model*) notation is called deviance (*Aitkin et al., 1989*), which in OLS is identically equal to the sum of square errors (SSE). In many applications, however, the comparison is not made to the saturated model. In assessing significance of an independent variable, one may compare the value of D with and without the explanatory variable in the equation. If this differences is defined as G, then

$$G = D(model\ without\ variable) - D(model\ with\ variable) \tag{3.15}$$

or

$$G = -2\left[\frac{max.\ log\ likelihood\ without\ variable)}{max.\ log\ likelihood\ with\ variable)}\right] \tag{3.16}$$

because the likelihood of the saturated model has come to both values of D (cancel out). This saturated model plays the same role in ordinal regression as does the numerator of the partial F test in OLS.

Akaike (*1973*) has shown that the maximum log likelihood is a biased estimator of the mean expected log likelihood. There is a tendency for the maximum log likelihood to overestimate the true value of the mean expected log likelihood. This tendency is more prominent for models with a larger number of free parameters (explanatory variables), which means that if the model with the largest maximum log likelihood is selected, the result will probably be a model with an unnecessarily large number of explanatory variables. He found that the relationship between bias and the number of explanatory variables of a model can be minimized by considering the number of parameters in the model assessment. In close examination of the relationship between the bias and the number explanatory variables (free parameters), Akaike proposed this statistics:

$$AIC = -2 \times [(ML\ Model) - (Number\ Free\ Parameter)] \tag{3.17}$$

Here AIC is an acronym for Akaike information criterion. So a model that minimizes the AIC (MAIC) is considered to be the most appropriate model. This definition implies that when there are several models where values of maximum likelihood or $L(\hat{\theta}, \hat{\boldsymbol{\beta}})$ are at about the same level, we would choose the one with the smallest number of free parameters. This is called "the principle of parsimony", which is always considered in this analysis. It should be noted that this likelihood ratio approach should be used when a sufficiently large sample size exists.

Another statistical test commonly used is the Wald's statistic. The Wald's statistic is obtained by comparing the MLE of the slope and intercept parameters γ_j and $\boldsymbol{\beta}^\top$ to an estimate of its standard errors.

3.4 SURVIVAL ANALYSIS

3.4.1 Proportional Hazard

The objective of survival analysis is to examine the dependency of children's stochastics survival time on a number of explanatory variables. Survival time is time defined as the time elapsed from the time of birth until death or until independent termination of child's observation, which is called "censoring". Here the predetermined and fixed censoring date is a date of our survey (interview), if a child is still alive in the household at that time. In addition, we define the time between the date of birth and the date of survey as a birth cohort time. Each child has a unique birth cohort time depending its the date of birth.

Life table methods have long been used by medical statisticians and actuaries to analyze such survival data. Before Cox (*1972*) introduced a hazard regression model, however, there had not been a convenient method of carrying out the survival analysis in such a way as to adjust for concomitant information. In 1972, Cox suggested a hazard function (*force mortality, instantaneous failure rate*) at time t, and regression vector $\boldsymbol{x}$ is taken to be of the form

$$\lambda_{\mu}(t, \boldsymbol{x}) = \lambda_0(t)\exp(\boldsymbol{x}\boldsymbol{\beta}) \tag{3.18}$$

where $\lambda_{(0)}$ is an arbitrary nonnegative function of t, $\boldsymbol{x} = (\boldsymbol{x}_1, \ldots, \boldsymbol{x}_p)^\top$ is a vector of the explanatory variable, and $\boldsymbol{\beta}$ is a corresponding column p vector of parameters to be estimated. The vector $\exp(\boldsymbol{x}\boldsymbol{\beta})$ is the risk associated with value $\boldsymbol{x}$ for a regression variable relative to a value of $\boldsymbol{x} = 0$. Here relative risk can vary with survival time by allowing the component of $\boldsymbol{x}$ to be dependent on time; that is, $\boldsymbol{x} = \boldsymbol{x}_{(t)}$. It should be noted that under Cox's model, the survival time is assumed as a continuous or interval scale, but its extension can accommodate ordinal survival time (i.e., grouped data).

In many practical applications, the measure of survival time may not be regarded as of practical importance unless regrouping data is performed. For example, age is often recorded in months rather than in exact days, or what works even better is if it is recorded in defined intervals (*i.e.*, $[0-1)$, $[1-2)$, $[3-6)$, $[6-9)$, $[9-12)$, *etc.*). This implies that the data is grouped as a discrete time (ordinal scale), and number of failures are likely ties at a certain interval.[2] A categorical data regression model may then be used for data analysis. For example, Cox (*1972*) proposed a model for discrete survival time which is very close the Mantel–Haenszel approach to survival analysis (*Mantel, 1966*). However, the meaning of the regression coefficient depends on the choice of grouping intervals (*Prentice and Gloecker, 1978*).

A partial likelihood function (*Cox, 1972, 1975*) may be used, including the discrete logistic model. When there is no "ties–observation"

[2] In our case, the number of failures are commonly found at the group $0 - 1$.

and assuming no time dependency of the covariate(s), the likelihood function for estimating $\boldsymbol{\beta}$ in the absence of knowledge $\lambda_0(t)$ can be estimated as follows. Suppose the case where a random sample of n individual yields a sample with k distinct observed lifetimes and $n-k$ censoring times is denoted $t_1, \ldots, t_k$, and $\Re_i = \Re(t_i)$ represents the risk set at time t_i, that is, the set of individuals alive and uncensored just prior to $t_{(i)}$. The likelihood function is

$$L(\boldsymbol{\beta}) = \prod_{i=1}^{k} \left(\frac{\exp^{\boldsymbol{x}_i \boldsymbol{\beta}}}{\sum_{\ell \in \Re} \exp^{\boldsymbol{x}_l \boldsymbol{\beta}}} \right) \tag{3.19}$$

where $\boldsymbol{x}_i$ is the regressor vector associated with the individuals observed to die at $t_{(i)}$. Here the partial likelihood basically is a product term, one from each distinct failure time. When there is only a small number of ties, it is suggested to use

$$L(\boldsymbol{\beta}) = \prod_{i=1}^{k} \left(\frac{\exp^{S_i \boldsymbol{\beta}}}{\sum_{\ell \in \Re} \exp^{\boldsymbol{x}_l \boldsymbol{\beta}}} \right)^{\delta_i} \tag{3.20}$$

where δ_i is the number of survival times equal to $t_{(i)}$, and $S_{(i)}$ is the sum of the regressor vectors $\boldsymbol{x}$ for these individuals. When a given number of failure times (m) are ties at time t, and n individuals are at risk just prior t, the partial likelihood contribution involves a summation over all possible subsets of size m for the n at risk. With our large data sets, such calculations are not feasible even with the rather finely grouped survival time. An alternative method, originally proposed by Kalbfliesch and Prentice (*1973*) and described in details by Prentice and Gloecker (*1978*) and Lawless (*1982*), should be considered here in order to developed computationally feasible estimates of the relative risk function and the corresponding survival function in the presence of many ties failure times. Prentice and Gloecker (*1978*) suggested that this current approach has an advantage in terms of relative risk interpretation, which is independent of the extent of survival time grouping and of efficient estimation of the relative risk parameter when given group data.

3.4.2 Discrete Proportional Hazards

Suppose survival times are grouped into intervals $A_k = [a_{k-1}, a_k)$, $k = 1, \ldots, r$ with $a_0 = 0,\ a_r = \infty,$ and that failure times in A_k are denoted as t_k. Also adopt our convention that a censored failure time t_k means that the child is known to have survived to the beginning of interval of A_k. The probability of observing a survival time t_k on a child with regressor vector $\boldsymbol{x}$ is time dependent but fixed within a specific time interval and can be derived from Cox's (*1972*) model as follows:

$$= \left[1 - \alpha_k^{\exp[\boldsymbol{x}(t_k)\boldsymbol{\beta}]}\right] \prod_{j=1}^{k-1} \alpha_j^{\exp\left[\boldsymbol{x}(t_j)\boldsymbol{\beta}\right]}, \tag{3.21}$$

where $j = 1, \ldots, r-1$. The value of

$$\alpha_j = \exp\left[-\int_{a_{j-1}}^{a_j} \lambda_0(\mu) d(\mu)\right] \tag{3.22}$$

is the conditional probability of A_j for child with $\boldsymbol{x}(t_j) = 0$. Here the value of $P(t_k, \boldsymbol{x})$, which is the probability of surviving to the beginning of interval A_k, can be written as:

$$P(t_k, \boldsymbol{x}) = \prod_{j=1}^{k-1} \alpha_j^{\exp\left[\boldsymbol{x}(t_j)\boldsymbol{\beta}\right]} \tag{3.23}$$

with specified grouping intervals of $k = 1, \ldots, r,\ j = 1, \ldots, r-1$, and includes a finite number of parameters $(\alpha_1, \ldots, \alpha_{r-1})$ and $\boldsymbol{\beta}$.

Our data were derived from a cross–sectional survey, and so precise measures of covariates at any given time are mostly unavailable. For example, times of immunization are lacking from the data sets, even though one may views it as a time–dependent covariate. Assuming a non–dependence of $\boldsymbol{x}$ on t, the probability of obtaining time t_k of a child with regressor vector $\boldsymbol{x}$ is

$$= \left[1 - \alpha_k^{\exp(\boldsymbol{x\beta})}\right] \prod_{j=1}^{k-1} \alpha_j^{\exp[\boldsymbol{x\beta}]}, \tag{3.24}$$

where subscript t is dropped from equation 3.21. Then the contribution to the likelihood for this particular child is

$$= \left[1 - \alpha_k^{\exp(\boldsymbol{x\beta})}\right]^{\delta} \prod_{j=1}^{k-1} \alpha_j^{\exp[\boldsymbol{x\beta}]}, \tag{3.25}$$

where δ denotes the censoring indicator ($\delta = 0$ if censored, $\delta = 1$ if failure), and $0 < \alpha_j < 1,\ j = 1, \ldots, r-1$. The likelihood function is the product terms of 3.25 over all individuals in the sample. Prentice and Gloecker (*1978*) suggested to define "link function" as $\boldsymbol{\gamma}_j = \log\left(-\log \alpha_j\right)$, so that the logarithm of the likelihood contribution of each children in the equation could be re–written as

$$l = \delta \log\left[1 - \exp(-\exp(\boldsymbol{\gamma}_k + \boldsymbol{x\beta}))\right] - \sum_{j=1}^{k-1} \exp(\boldsymbol{\gamma}_j + \boldsymbol{x\beta}) \tag{3.26}$$

The log-likelihood function $(\log L(\boldsymbol{\gamma}, \boldsymbol{\beta}))$ can be written as

$$\sum_{k=1}^{r-1} \left(\sum_{j \in \mathcal{F}_k} \log(1 - \exp(-\exp(\boldsymbol{\gamma}_k + \boldsymbol{x}_j\boldsymbol{\beta}))) - \sum_{j \in \Re_k} \exp(\boldsymbol{\gamma}_k + \boldsymbol{x}_j\boldsymbol{\beta}) \right), \tag{3.27}$$

where $\mathcal{F}_k$ is the set of children failing in A_k and $\Re_k$ is the set of children surviving throughout the whole period of A_k. The MLE of the survivor function estimator at the t_k can be written as

$$\hat{P}(t_k;\boldsymbol{x}) = \prod_{j=1}^{k-1} \exp\left[-\exp(\hat{\gamma}_j + \boldsymbol{x}\hat{\boldsymbol{\beta}})\right] \tag{3.28}$$

The asymptomatic normal distribution of $\hat{Y} = \log\left[-\log \hat{P}(t_k;\boldsymbol{x})\right]$ may be considered for interval estimation on $\hat{P}(t_k;\boldsymbol{x})$.

To examine the goodness of fit of the model, one may use a score statistic, likelihood ratio test, and Wald's statistics. The score statistic can be calculated based on

$$\frac{\partial L}{\partial \boldsymbol{\gamma}_k} = \sum_{\ell \in \mathcal{F}_k} b_{kl} - \sum_{\ell \in \Re_k} h_{kl} \tag{3.29}$$

and

$$\frac{\partial L}{\partial \boldsymbol{\beta}_j} = \sum_{k=1}^{r-1} \left(\sum_{\ell \in D_k} \boldsymbol{x}_{jl} b_{kl} - \sum_{\ell \in \Re_k} \boldsymbol{x}_{jl} h_{kl} \right) \tag{3.30}$$

where $h_{kj} = \exp\left(\boldsymbol{\gamma}_k + \boldsymbol{x}_l \boldsymbol{\beta}\right)$ and $b_{kl} = h_{kl} = h_{kl} \exp^{-h_{kl}} \left(1 - \exp^{-h_{kl}}\right)^{-1}$.

The details of the algorithm of MLE calculation are given by Kalbfliesch and Prentice (*1980*), Lawless and Singhal, (*1987a, 1987b*), Prentice and Gloecker, (*1978*). These authors also noted that instability in the Newton-Raphson procedure may occur, if the number of failures in specific time intervals is sufficiently small. Under such conditions, it is suggested that the estimation based on the partial likelihood discussed early may provide a more attractive alternative. However, when the numbers of failures is large, this method provides a useful estimation procedure that involves precisely the same estimated of relative risk parameter, $\exp(\boldsymbol{x}\boldsymbol{\beta})$, as in the continuous model. Furthermore, model selection and comparison will follow rules of a generalized linear model, as discussed in a previous section (*Aitkin et al., 1989, Kalbfleisch and Prentice, 1980*).

Chapter 4

RESEARCH METHODS

4.1 INTRODUCTION

This chapter will describe the design and implementation of the survey, including the instruments used for data collection. Some basic data about the study setting will be described in the next chapter, mainly from our survey finding. This survey is a single, round household survey (*HHS*) which was conducted by the Regional Health Office of Nusa Tenggara Timur (*RHO–NTT*). The survey gathered information on: 1) household structure and environmental conditions, 2) demographic characteristics of each individual at all of ages, 3) birth and pregnancy history, 4) anthropometric status of children under–5 years old, and 5) survival status of all births occurring over the past five years.

Besides data from HHS, information on health facilities, services, and process indicators were collected from existing routine registration records and direct interviews to the health providers. Data related to a social economic development of the survey area came from interviews of village and subdistrict leaders and secondary data from the routine reports.

4.2 SURVEY DESIGN

4.2.1 Selection of The Target Population

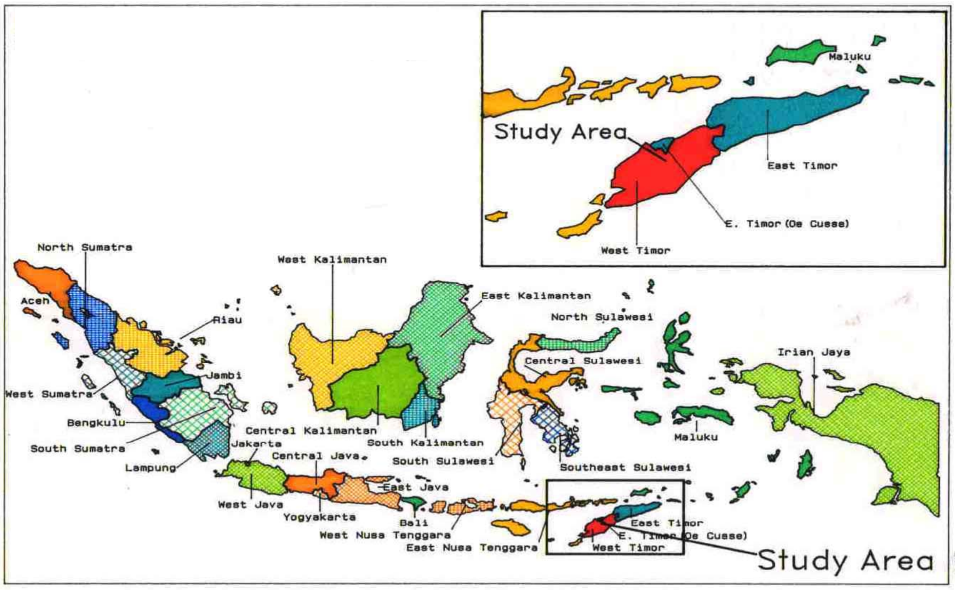
This survey was implemented in the West Timor Island in the Province of Nusa Tenggara Timur(*NTT*). This province is located in the eastern part of the Republic of Indonesia. Figure 4.1(*page 101*) shows map of the Republic of Indonesia and the study area.

The selection of this study area was based on the fact that only a few child survival studies have used data from the eastern part of the country. Data have shown a persistently higher level of IMR in the east part compared to the western part of Indonesia (*Oetomo and Iskandar, 1986; Hull and Hull, 1984; Oetomo and Iskandar, 1989*). Thus available information on the determinants of child survival in Indonesia may have overlooked some important factors in the eastern part of Indonesia.

The Government of Indonesia has been putting many efforts to reduce IMR in the eastern regions by implementing several general developmental projects, including health projects (*Ministry of Health, the Republic of Indonesia, 1983; Yahya, 1985*). One of the health projects relevant to child survival problems was implemented from 1982 to 1989 by RHO–NTT under cooperation with the United States Agency for International Development (*USAID*), namely the Comprehensive Health Improvement Program–Province Specific or abbreviated as a CHIPPS Project. This survey is part of the project evaluation of 1988/1989.

The primary objectives of the CHIPPS Project were to strengthen the abilities of provincial health officials to target, manage and evaluate health/nutrition interventions that will improve child and mater-

Figure 4.1: THE REPUBLIC OF INDONESIA AND THE STUDY AREA, 1988



nal survival, and to contribute to the decentralization of health services in the three outer island provinces, including NTT, Aceh, and West Sumatra. The project was carried out mainly through support for training health personnel and health intervention community trials, which were selected based on epidemiological data collected and analyzed in the provinces. It was anticipated that by the end of the project the quantity and quality of rural health personnel would improve, particularly in their analytical and managerial approach for implementing health programs.

Although the CHIPPS project covered all areas of the NTT province, the survey covered only West Timor Island, which constitutes about 37 percent of the total population of NTT. The rest of the total population are scattered across more than 15 islands. There were two important reasons why we did not cover areas outside West Timor Island: 1) geographic conditions and the size of our budget limited us to implementing the study to our target population, 2) there is evidence that the implementation of the CHIPPS project was not well written or documented in the places.

4.2.2 Geographic Coverage

West Timor Island is 14,394 squares kilometers in size and it is divided into 4 administrative districts (*Kabupaten*): Kupang, Timor Tengah Selatan (*TTS*), Timor Tengah Utara (*TTU*), and Belu. These 4 districts are divided into 36 sub–districts (*Kecamatan*). On average each sub–district comprises 17 administrative villages (*KALURAHAN*) and each KALURAHAN is divided by a smaller administrative boundary lines into hamlets (*DUSUN*). In total, our target population has 505 KALURAHAN or 715 DUSUN.

Consistent with the central government's policy, each subdistrict generally has one Primary Health Center (*PHC*) or "Pusat Kesehatan Masyarakat" (*PUSKESMAS*). Each PUSKESMAS is designed to cover the population within a subdistrict. Therefore it is possible to divide PHC–catchment areas (*PHC–CA*) into a smaller units such as villages or blocks. Appendix 4.1 shows the list of PUSKESMAS, number of villages and blocks in our target population.

During sample selection each PHC–CA was divided into census blocks using a sampling map provided by The Regional Statistical Office of NTT (*RSO–NTT*). Among these 36 strata, there are 2,077 blocks listed in the *National Social Economic Survey, 1987*(SSN 87-LI form). Data on the number of household and the population of each census block was also obtained from RSO–NTT; less than 0.5 percent were unknown. It should be noted that the boundaries for block areas are very clear since in most cases these are naturally occurring geographic boundaries such as a river, road, forest, or mountain. This block classification had been used in many surveys since the 1980 census.

4.2.3 Sample Design

The main objective of RHO–NTT was to collect information on the utilization of health services for children under the age of 5 years at each PHC level. One area of major interest was to measure prevalence of BCG, DPT, and polio immunizations at the PHC level, and to assess determinants of their utilization at the aggregate level. Thus the survey design should be able to produce reliable estimates for each stratum (*stratum prevalence rates*), and to obtain a sufficient sample size for the aggregate level analysis.

To achieve such objectives, the survey utilized a multistage sampling procedure with stratification. The PHC–CA were used as the strata, so that randomization was performed at each stratum. All available strata (*36 PHCs*) were included in this study, therefore strata selection was not performed. Thus we selected blocks within strata as the first step of selection.

At each stratum, the first stage consisted of selecting a number of census blocks with a probability proportional to the estimated number of households in the blocks. At the second stage, households were selected randomly from the list of all of the blocks sampled. At this stage an actual list of the households was randomly selected by generating a random number using a computer program concurrently with the sample size calculation for each stratum. Sample size of each PHC should have a minimal size required to generate utilization statistics at each PHC level. Obviously, the sampling fraction of each PHC would be different, depending on the size of the population within PHC–CA. Since all PHCs were included in this study, one may consider PHC as a stratum factor if the main interest is the total population of the four districts. Hence for the total population estimates, the sampling weight will be proportional to the total size of the household for each PHC. All population estimates were then calculated by considering this sampling weight.

To perform this sampling selection we required two pieces of information: 1) the estimated number of households or actual size all of blocks, and 2) the actual list of household within blocks selected in the first step of sampling selection. Ideally we would have to construct a list of all of the households in our target population (*to give a sampling frame*). But such listing procedures take a lot of effort and resources, since the geographic conditions and transportation in this area was very difficult. An alternative procedure therefore was considered. For the first step of sample selection, we used estimated sizes of the blocks from existing information.

The RSO–NTT has been conducting many surveys in recent years, and all of the households covered in our census blocks were listed on the SSN 87–LI form. This form was used by RSO–NTT in selecting samples from the National Social Economic Survey in 1987. This particular form was also used in our survey. However, during a one–year period the actual number of households in each block may have changed, even though due to a low level of migration this change would not be substantial (*CBS, 1987*). To overcome this problem we decided to revisit each block. Only households in the block selected as samples were relisted. The results were compared to the previous list from the SSN–87–LI form. But after half of total blocks were revisited, we decided to stop the activity for several reasons: 1) the households listed on SSN 87–LI form were covering more then 99 percent of the actual list, 2) considering the time schedule related to weather and geographic conditions, it was not practical to postpone the main survey due to mapping or listing activities, and 3) a shortage of budget for this activity.

At the end, half of the household selection within the blocks sampled had to be done entirely based on the SSN–87 LI form. So we anticipated that some of HHs listed would not be found in our field visit. Therefore we inflated our sample sizes according to this anticipation of missing respondents (*about 5 percent*). This number has been included in our sample size calculation as well as in our random number generation.

4.2.4 Sample Size Estimation

Apart from the original survey goal, the sample size estimation for the total population can be extrapolated directly for our study purpose. Given that the total sample selected was more than 8,054 households, to test the hypothesis of differences in any proportion of outcome between two groups can be justified using calculations presented in Appendix 4.2. Furthermore, one may calculate a sampling error for a specific proportion derived from the formula in Appendix 4.2 (*Kalsbeek, 1982*). However, it is not clear how one should justify adequacy of our sample size if we were to perform a multivariate analysis.

4.2.5 Sample of Households, MWRA, and Under–5 Children

Our sampling frame comprised of 913,466 subjects or 184,129 households, scattered across 2,077 census blocks or 36 strata (*PHC–CA*). Sampling selection was conducted such that each strata (*PHC*) can be presented by a drawn sample. On average, each stratum has 58 blocks and about 8 of them are represented in the sample. Out of 2,077 blocks in our target population, 270 blocks were sampled for this study. This implies that about 13 percent of the total blocks are present in the sample. However, not all households within the blocks were automatically interviewed, since random selections of each household were performed to obtain only about 225 household per stratum. In total, 8,054 households were able to be interviewed out of the 8,100 listed in our sampling frames. It should be noted that the minimum sample size required for each PHC was 225 households, in order to cover about 120 children under age 5 per PHC. In most cases, the number of children targeted was achieved, although some of PHCs yielded a smaller number than expected. This is because our sampling fraction was not based on the list of children but rather on the list of households.

Our sample covers data on 39,362 persons, or 6,032 married women under 55 years of age. However, the analysis will only consider married women aged 15 to 49 years, which overall covers 5,974 women (*MWRA*). A total of 22,440 births were reported to occur among these MWRA, and 2,978 of these were reported to have died. Out of total children ever born, only 5,303 were born during the last 5 years, and of these, 282 children were reported to have died. For six deaths, the exact dates of birth and death were unknown (*they were known to have been born or to have died after the year 1984*), and four deceased children were excluded from analysis because it was suspected that they had not lived with their biological mother.

Among the 5,021 surviving children included in the interviews, 297 of them could not be included in the multivariable analysis for the following reasons: 1) 105 children did not live with their biological mothers (*adopted by a grandmother or other relative, parents divorced, or mother died*), 2) 101 children were rejected because age was not known to an exact month (*i.e., they reported without month of birth*), and 3) 91 children excluded due to an invalid ID or as a result of non matching to mother's and family information (*i.e., child's age less then one month but mother's age older than 49 years, which is beyond the biological plausibility for this study area*).

Finally, among 4,724 children with mother's and family characteristics, 4,454 of them had valid anthropometric data and other mother and family characteristics. For some children their weight, height, and BCG scars could not be measured during our visit periods in that village. And some of them could not be measured because of ob-

Figure 4.2: CHARACTERISTICS OF SAMPLE OF TIMOR CHILD SURVIVAL STUDY (TCS), 1988

SAMPLING DESIGN:
A MULTISTAGE WITH STRATIFICATION

- TARGET POPULATION:
  - Area: 14,394 squares kilometers
  - Districts: 4
  - Subdistricts: 36
  - Villages: 505
  - Hamlets: 715
  - Blocks: 2077
  - Households: 184,129
  - Subjects: 913,466
- SAMPLE:
  - Districts: 4
  - Subdistricts: 36
  - Households: 8054
  - Subjects: 39,352
  - MWRA (15-49): 5974

5974 MWRA

22,440 BIRTHS

5303 children were born in the past 5 years

5021 Survive	282 Dead
(94.7%)	(5.3%)

4715 for Survival Analysis
(88.9% of children born in the past 5 years)

4452 for Index of Health Status
(84% of children born in the past 5 years)

jection from the mother. This rejection occurred either when the child was very sick or at a very young age (*less than one month*). In addition, some missing observations on certain variables cannot be avoided, due to problems either created by survey non–response and/or arising from the data editing.

4.3 SURVEY INSTRUMENT AND STUDY IMPLEMENTATION

4.3.1 Instruments

This survey utilized three questionnaires and several forms for secondary data collection and supervision of the field activity. These three questionnaires covered: 1) household and individual characteristics, 2) community and environmental variables, and 3) health sector information. Interviews on each category were conducted by personnel trained for this purpose. To standardize the conduct of the survey and data processing, there were two manuals (*one for interviewers and one for supervisors*) and one a data code book compiled for this survey.

Household and individual characteristics

The household and individual characteristic forms were divided into five types as follows:

1. a family or household structure characteristic data form (*type A*),
2. a form for all ever married women below 55 years of age (*type B*),
3. a form for surviving children under 5 years of age (*type C*),
4. a form for non–surviving children born within the last five years (*type D*), and

5. a form for the growth and immunization card (*type E*).

Appendix 4.3 describes these 5 forms in detail.

Each part was printed in a different color for the convenience of the interviewers. In the first step, the head of the household was asked questions about the names of members of the household and information on: sex, age, and marital, educational and occupational status. If the household list showed that there was a woman who had ever been married below 55 years, then a further interview was conducted with them. The more intensive interview with the woman was conducted as a separate conversation. To avoid interference from the husband and other relatives, a specific explanation was given to the respondent and other members of the household during the introduction phase. This information include the right of the respondent to refuse the interview. However, after the whole interview was completed, we could still ask the husband or other family members to find birth certificate, growth card, and immunization card for their children.

During the interview with the woman, there would be questions on whether she had any children born within the last 5 years. If the child was still alive, we gave a letter/card appointment for measuring the child's body weight, height, and BCG–scar. The anthropometric examination was usually conducted by the group leader of interviewers in the house of the hamlet or village leader. Besides logistical reasons, this procedure would hopefully improve reliability of the data by reducing the observer's variability. If a woman did not comply with our invitation, then her children were examined at their own home. It should be noted that when a baby was less than 35 days old, some mothers would not allow interviewer to exam their baby's weight and height.

Weight was measured to the nearest 100 grams with beam–balance scales with the children wearing only minimal clothing. Height was measured to the nearest 1 mm with standard equipment. Recumbent length measurements were taken on children below 24 months and stature measurements on children 24 months or over.

Community and Environmental Characteristics

This part covers information related to community or regional characteristics. Sources for these data are mainly from observation and interviews with village and sub–district leaders. Other data were also collected from a local key leader, i.e., number of health cadres and visit of family planning or health providers to the village. Most of information is also routinely collected by the government, since its used as a measure regional development by The Interior Ministry of Indonesia. More specifically information covers: 1) geographic conditions, 2) land quality and production, 3) distance to public facilities such as hospital, clinic, school, market, and public transportation, 4) availability of school, mosque, hospital, shop, market, bank, Post Office in the village, 5) frequency of visit by family planning and health providers to the village, 6) number of cadres in village, and 7) activity of the local community organization.

Health Sector Information

These forms cover information on the provider characteristics, utilization of some health services (*recorded by the providers*), and the number of health services distributed by providers. Most of the information, however, concentrates on aspects related to the immunization program.

4.3.2 Survey Implementation

Organization of the Survey

The implementation of the survey was directed by a steering committee formed by the Head of RHO NTT on May 1988. This committee consisted of RHO–NTT staff personnel. Data processing for the survey was mainly assigned to the staff of the Population Studies Center, Gadjah Mada University. Two professors and two graduates students from the Johns Hopkins University, School of Hygiene and Public Health provided assistance in almost all of processes of the survey, from preparation/planning, sampling and questionnaire design, to analysis of the data, including cost of data processing which was obtained from the Ford Foundation. The USAID provided major funding for this survey with some additional funds from the local government of NTT.

A field coordinator was appointed for each district to be responsible for all phases of survey implementation in each district. The field coordinators were teachers of community medicine at The School of Nursing in NTT. The Chief of Health District took responsibility for administrative and technical implementation of the survey in the district area. To accomplish their tasks, all of them attended a special training session. The RSO–NTT staff at the subdistrict level (*Mantri Statistik*) and the subdistrict leader took part in this survey as guides for interviewing, especially during the construction of the sampling frame.

Thirty–nine interviewers for this survey were graduated from School of Nursing, and most of them were females (*80 percent*). They were divided into six groups, and each group was led by one of its most respective members. All of them had experience in the field survey.

Training and Pretest

The training was conducted in seven days and followed a standardized manual. This training consisted of explanations of the survey procedures, instructions on how to fill out the questionnaires and how to conduct interviews, and discussions on issues related to health questions. The format of this training was lectures and a simulation.

The pretest of this survey was conducted in two villages not covered in our sampling frames. The pretest took place in August 1988 and involved all interviewers. The goals of the pretest were: 1) to test the appropriateness of questions and manuals, 2) to observe field activity in order to estimate an appropriate work load for the interviewers, 3) to observe interview conducted in the local language (*i.e., helong, tatum*), and 4) to study the readiness of survey staff in terms of flow activity. The pretest field work was completed in one week. After pretest, interviewer training was performed again using a form with the final format. A one–day field visit was judged adequate for the second field–testing since there were not many corrections to the previous form. At this stage interviewers were also given job–descriptions, including targets and a time table that should be followed. On average, each interviewer was limited to conducting 3–5 household interviews per day. It was important to stress this matter to allow interviewers to check and edit respondents' answer right away.

Data Collection and Processing

The field work was not carried out simultaneously throughout the four districts, but it was initiated from the area with a very bad geographic condition during the rainy season. This survey was started on September 1988 and ended in the second week of December 1988. Data collection was carried out by teams which moved from one block to another within a subdistrict.

To obtain full cooperation from the public in the sample areas, the supervisor or group leader made contact with the local authorities through the respective PHC leader or subdistrict leader. At the village level, the local women's organization (*PKK*) was contacted to inform them of the upcoming visit by our survey team. This approach proved to be effective as there were no major societal problems during the field work.

The most difficult problem in the interview was to obtain the data relating to time, such as hour, month, and year. For example, duration to reach the work place, month and year of marriage, date of birth of their children all of these were difficult to obtain and it was time consuming. However, these were very important data, so we asked interviewers to collect data with patience and care. In some instances, probing questions which linked a certain event with the time–related question were asked, and this technique turn out to be very helpful.

As part of data cleaning, editing was done first by the interviewers. The questionnaire submitted to the group leader was checked for completeness, consistency, and accuracy. Next, the group leader submitted the questionnaires to the field supervisor and the supervisor then carried out the same procedure. All of these activities were closely supervised by the principal investigators. Finally, data were transferred to the coding sheet and sent to the data center in Yogyakarta. We did not transfer data from the questionnaires directly to the computer, since it was very unlikely to send the whole questionnaires to Yogyakarta. Obviously this approach increased our work load and increased the possibility of data coding errors.

Data processing involved transferring the data recorded on the code sheet to diskette. This step was conducted in The Computer Center of Population Studies, Gadjah Mada University using 12 micro–computers. In addition to the use of computer program on automatic data checking, verification of recorded data was also performed on a random basis to check logical errors during data entry. Data errors found in this step were verified directly against the code sheet. If the code–sheet was actually correct but inconsistent with our data entry program, then we sent it back to Kupang for verification from the original questionnaire.

Before analysis in The Academic Data Center of the School of Hygiene and Public Health, Johns Hopkins University was conduced, the data were merged and edited for consistency, using a series of specially designed rules to minimize existing errors. We used some Fortran programs and a SAS–macro language (*PC–Version 6.03*) for this purpose. Again, records with errors were reverified against the original questionnaires in Kupang.

Descriptive and other simple analysis was done using a SAS program (*1985*). To reduce the cost of a screening model, however, multivariable analyses were mainly performed using a program written in Fortran–77 which followed Lawless and Singhal's algorithms (*1987a, 1987b*). The program has more 4,750 lines, and the program works both in the micro and mainframe computers. In the first step, we tested the accuracy and reliability of calculation using microcomputer. In this case program was compiled using Microsoft Fortran compiler version 5.0. (*IBM–PC version*). Before the program can be used in the IBM mainframe computer, it requires some modification since VS–FORTRAN mainframe is not exactly comparable with Microsoft Fortran version 5.0. All analyses were performed in the mainframe computer since it requires an extensive iteration, so that the personal computer would not be practical for the large data set.

Indirect estimation of infant and child mortality were calculated using computer program kindly provided by Professor Kenneth Hill and Mortpak–Lite software from the United Nations Population Division (*1986*). The nutritional status indicators were derived from the height and weight data on each age and sex using the CAPS program from Centers for Disease Control (*CDC*) (*Jordan, 1986*)

4.4 STUDY VARIABLES

4.4.1 Reliability Of Information

Three major sources of threats to reliability are discussed below. First, errors due to the inability or reluctance of respondents to provide the correct answers to questions, second, coding errors, and third, errors in anthropometric measurements.

Response Errors

Response errors occur when respondents are unable to give accurate responses because they do not know or cannot remember the correct answers. Although “do not know” is provided as an alternative response whenever appropriate, respondents may have felt embarrassed to admit their ignorance, and then guessed at an answer which seems reasonable, especially after “a probing question” proposed by interviewer. This is likely to occur when a question was asked regarding a vital event, such as date of marriage, date of birth of their children, etc., where the truth is often difficult to place accurately in time if recall periods exceed a few years. In such cases, we tried to obtain reliable data by looking at written records, such as birth and marriage certificates. For illness episodes, the recall periods were always within two weeks, so respondents were more likely to be able to remember, even for a mild illness (*Martorell, et al., 1976*).

Underreporting of births and death of infant at neonatal periods is a common finding in LDC surveys, particularly among the least educated women for whom the concept of calender time has not been perceived as important (*Kroeger, 1983; Hill, 1984*). To address this issue, we used a standardized Brass type questionnaire for indirect calculation of level and trends of child mortality. However, questions related to direct measures of child mortality required recall for births and death occurring over the past 5 years. Despite special efforts given during interviews (*such as probing, conformation with other family member and checking against authentic records when available*), the reported number of deaths occurring over the past 5 years is considered lower than our expectation. Therefore, on the calculation of level and trends of child mortality, we did not use this information. We did use this information to assess the risk of death at the individual level. Obviously, it does not avoid bias in the final results, even though it is not likely to give an overestimate of risks factors. Many studies suggest that underreporting of deaths occur more often among less fortunate mothers (*i.e., poor, less educated*), whose children have a higher risk of dying (*Kroeger, 1983*). If this is true, the proportion of deceased children among a high risk group will be lower than expected. Accordingly, the estimate of relative of risk will also be lower than expected if there is no underreporting among a low risk group.

Most of the remaining questions utilize relatively short–term recall (*expenditure within the last 3 months, sickness within last 2 weeks*) and refer to present objective conditions, such as availability of modern household amenities, animal live stock, and availability of latrine facilities. Even so, respondents' reluctance to provide accurate information was encountered when questions were asked regarding the number of animals they own (*horse, carabao, cow, pig, and chicken*), and the amount of land owned by the family. The reason may relate to the current strict regulations for the taxation system which consider amount of taxes for animals and land. In some areas, this may result from the fact that large animals (*horse, carabao, and cow*) usually do not belong to individual households, but rather they belong to the familial root (*"suku"*). The problem was encountered less when respondents were asked about their expenditures. Obviously, in an effort to maximize the participant's cooperation in the answering of these questions, we explained that interviews had nothing to do with taxation. Since interviewers were wearing a paramedics uniform; this effort was quite successful in obtaining cooperation from respondents.

Coding and Record Linkage Errors

Our computer program were designed to check coding and inconsistency errors within a single form (*file*) during data entry. Since we have multiple forms, inconsistency between forms (*files*) had to be performed separately. For example, after record linkages showed that a woman never had a delivery she should have no child information. If this was not the case after record linkage, we went back to individual questionnaires to check incorrectness of the identification. This is the most time–consuming process since we have hierarchial files with 5–levels: children, mother, family, village (*block*) level, and PHC level information. If an error was not found, information was deleted from the data sets (*missing values*). In general, these data have a few missing values due to coding and record linkage errors.

Anthropometric Measurements Errors

The accuracy of the anthropometric measures obtained during this survey is a critical factor in the analyses of our study. Despite extensive training, supervision, and routine calibration of the equipment, the systematic measurement errors were reduced even further by measuring weight and height at one place by one examiner. Nevertheless, inaccurate "matching" of weight or height with the children's age still occurred. In most cases, these errors can be corrected by reexamining ages which were entered incorrectly. If data still did not match, it was necessary to assess the likelihood that a given weight for age, or a given height for age, the Z–score value was within the realm of physiologic possibility. As a practice suggested by NCHS (*Mercer, 1987*), a weight for age or height for age outside the range of 3 sample standard deviations from study population mean was rejected as likely to represent incorrect measures. In our sample, any value below -7.8 Z–score was rejected from the study. If it did occur, we deleted all the anthropometric data for this child. However, this did not exclude improperly matched cases between weights and ages or height for ages when calculation is resulted in Z–scores that were within 3 sample standard deviations from the study population mean. We examined that this type of error was randomly distributed in the study population and therefore should not bias in the results.

4.4.2 Variable Selection and Simplification

Variables defined in the next section were selected on the basis of proposed hypotheses and conceptual frameworks followed in the analysis. We tried to use the most reliable information available in the questionnaire. For example, whenever available, we calculated ages of children using the date of birth on the birth certificate. Otherwise, ages were calculated from less reliable information such as a baptism card, or from least reliable information, that is, respondent's answer.

Some variables were recoded to a different scale or even became a new variable in the data sets. For example, nutritional status indicators were derived from weight, height, and age information and presented on Z–scores. From the Z-score, data was recoded to an ordinal or dichotomous scale. Much data recoding was performed for the risk factors analysis. This effort was intended to obtain meaningful and easily interpretable results. By changing scale from interval or continuum to a categorical form, the estimates of relative risks can be obtained and interpreted easily. Obviously, balancing easy interpretation, some precision is lost due to this simplification.

4.4.3 Variables Definitions

We examined 4 group variables that according to our theoretical framework will explain the relationship between health system variables, socioeconomic variables and mortality or nutritional status. Many variables listed were excluded from multivariable analysis after descriptive statistics did not suggest them to be important factors. We considered analysis based on the mother and child as the unit analysis. Consequently the independent variables will vary according to the availability of information at the unit of analysis and outcome considered.

Outcomes Variables

1. Proportion dead among children ever born. For the first step of analysis, we consider the woman as the unit analysis. We used information on the proportion of dead among children ever born and duration of marriage or age group of women for aggregate analysis. Based on this information, the probability of dying up to certain children's ages (*i.e., IMR*) can be estimated and classified according to the characteristics of the woman or the household. For individual analysis, the expected number of child deaths for each woman (*considering parity and marital duration*) is calculated according to Trussell and Preston (*1982, 1984*) methods. Then covariates are estimated based on the ratio of observed to expected child deaths for a certain duration of marriage of the woman. This allowed conversion of information from mother to each individual child (*Trussell and Preston, 1982; 1984*). This is called "a mortality index", and will be explained in Chapter Six.

2. Survival status of children. Using a child as the unit of analysis, we will examine factors associated with the survival status of children born within the last 5 years. Analysis using children as the unit analysis will have more detailed covariates associated with mortality than using the mother as the unit of analysis.

3. Nutritional status of children. The prevalence of malnutrition can be measured based on the height for age, weight for age, and weight for height of the children under 5 years of ages. Descriptive analyses are performed using the prevalence rate according

to certain characteristics of each PHC. The multivariable analyses are conducted on the determinants of wasting and stunting on each child (*child as the unit of analysis*). Details of this definition will be given in Chapter 7.

4. Index of Health Status. The final steps of analysis are performed using the index of health status (*IHS*) by combining nutritional and survival status of the children as the outcome variable. The IHS is measured on an ordinal scale, with 5 categories which will be described in detail in Chapter 8.

Proximate Determinants

1. Preventive and curative measures.

   (a) Antenatal Care (*ANC*): Using the mother as the unit of analysis, we have information on the number of antennal visits during of her lifetime. The number of antennal visits was reclassified into three categories: 1) never had ANC, 2) had ANC $1-3$ times, and 3) ANC more than 3 times. We used this variables as a proxy of the willingness of a woman to seek preventive health service which is obviously influenced by the health system variables. For children as the unit analysis, the ANC information is applied for the child being interviewed.

   (b) Use of Contraceptive methods: The use of a modern contraceptive method is classified in two categories: 1) never used and 2) ever used any modern contraceptive method. This variable will be with both mother or child as the unit of analysis. We also used a history of previous contraceptive use before birth of child in the analysis.

(c) Immunization: The child immunization variable is only used when a child is considered as the unit of analysis. Immunization status was divided into three categories: 1) never received immunization, 2) received some but incomplete, and 3) received complete immunization. We define complete immunization as having received one BCG, two DPTs and two polio immunization. An alternative measure is the BCG–scar when only survivors are considered. This BCG–scar variable has two categories: 1) a positive BCG scar, and 2) a negative BCG scar. Because the method of immunization will depend on the age of children, the analysis should deal with this issue specifically. Beyond child immunization, the tetanus toxoid (*TT*) immunization for the mother is also considered in the analysis. There are two categories for this variable: 1) never received TT immunization and 2) ever received TT immunization.

(d) Growth Monitoring: The growth monitoring variable was used for both mother and child as the unit of analysis. When mother is used as the unit analysis, the growth monitoring variable is divided into two categories: 1) women with a growth card or 2) women without a growth card. These categories may be viewed as a proxy for personal illness control. When children are used as the unit analysis, the growth monitoring information is based on the question regarding whether child has been brought to weighing program and received a growth card. This variable has two categories: 1) never been weighed, and 2) ever been weighed.

(e) Birth Attendant and Place of Births: This variable is collected for each child born within the last 5 years. The birth attendant variable is used to measure curative/preventive control at the time of birth and is divided into three categories: 1) birth attended by someone other than a traditional birth attendant and health professionals, i.e., attended by family and relative only, 2) birth attended by traditional birth attendant, and 3) birth attended by medical professionals, i.e., a paramedic or a medical doctor. It is possible that a birth was attended by more than one of categories above. In this case, we considered the best (*the highest category*) attendant in the response. An alternative measures for this concept is a place of birth that was divided into two categories: 1) birth at home, and 2) birth at a medical facility.

(f) Availability of Modern Drugs or ORS: This variable is used as a proxy of curative measures. Any family having modern drugs at the time of survey (*anti–cold, anti malaria, ORS, etc*) is considered in a category of having modern drugs. A more restrictive question was asked for ORS only. All of these variables have two categories: 1) No and 2) Yes.

2. <u>Maternal factor.</u>

(a) Parity: Parity is defined as the number of children ever born. It is assumed as a continuous variable which will be also recategorized in the multivariable analysis.

(b) Mother's age: Only for indirect estimation and descriptive analyses, this variable is divided into seven classes with a five–year intervals starting at age 15, otherwise mother's age is used as a continous scale.

3. Environmental Sanitation:

   (a) Toilet Facilities: This variable is defined as the availability of toilet facilities within the household. Three categories are identified: 1) household has no toilet facility, 2) household has a pit latrine or a latrine or with no a septic tank, and 3) household has a flush latrine or a septic tank.

   (b) Source of Water for Drinking, Cooking, and Washing: Water source had three categories: 1) river or artesis, 2) well, and 3) pipe or tap water. For multivariable analysis we recategorized the above into two classes: 1) non–pipe and 2) pipe water sources. This variable is a proxy for the water quality and environmental contamination, but it is not a measure a quantity.

   (c) Floor and Wall: Environmental housing conditions are measured based on the materials in floors and walls. We used two categories: 1) nonconcrete materials, i.e., bamboo, grass, and wood, and 2) concrete materials. A floor or wall made of concrete material is assumed to be a better environment than nonconcrete material.

   (d) Crowding Index: Crowding index is defined as the number of persons living in the households divided by area of house for living members (*unit is person per square meter*). This variable is a measure of the degree of potential air contamination and risk of contact–acquired respiratory infection. We recategorized the above into two classes using a median of total samples as a cut value, i.e., 1) below median, and 2) median and above.

(e) Availability of soap for bathing: This variable is a measure of personal habit associated with healthy sanitation. There are two categories of household: 1) having no soap, and 2) having soap. A household with soap is considered better in sanitation practice than the other.

4. Nutritional Factors. Breast Feeding: Children were classified into two categories: still continue breast–feeding and stopped breast–feeding by the time of the survey. In the multivariable analysis, however, the effects of current age will be considered in the models.

Socioeconomic Variables

Socioeconomic variables of the household are measured based on the data on income, wealth, education, health knowledge, occupation, and membership in a social organization.

1. Income. It is difficult to measure the real income of a household, therefore we considered the following proxies variables:

   (a) Household Total Cash Expenditures: This is the total expenditures of a family in Rupiah (*Indonesian currency*) per month, and it was averaged from the last 3 months expenditures. On a continuous scale, these expenditures will be re–expressed into a natural logarithm scale because of its skewed distribution. We re–classified respondents into two categories: household with expenditures equal to or below the median expenditures of total sample, and family with higher expenditures than the median for the total sample.

(b) Main Sources of Income: Households are classified in two main groups according their main sources of income: nonagricultural and agricultural sectors. We defined main income according to the total amount of income obtained if they worked in more than one sector. It may also represent an individual's social status as a farmer or nonfarmer.

2. Wealth. To figure out about family wealth, we measured based on the ownership of modern amenities and animal livestock.

   (a) Ownership of Modern Amenities: We defined household according to two categories: having modern amenities and not having any modern amenities. If household owned either a stove, gas lamp, car, clock, radio, television set, or car, they were classified as having modern amenities.

   (b) Ownership of Animal livestock: If household had at least five cows, carabaos, or horses, they were considered to have animal livestock. Otherwise they were considered as not having animal live stocks.

   (c) Electricity: Households were categorized into having electricity or not having electricity. This variable may serve as a proxy for modernization and wealth.

3. Parent's education. Mother and father's education were classified according to their level, even though duration in years of schooling is also available. Both measures are very close, i.e. complete primary school can be translated as at least 6 years in the school systems, while secondary and above means at least 9 years in the school.

(a) Maternal Education: Maternal education is defined as the level of formal education last attended (*completed*) by a woman. The four levels identified are: 1) none, 2) some primary school, 3) primary school completed, and 4) secondary school and above.

(b) Paternal Education: Paternal education is defined as the level of formal education last attended (*completed*) by the father. The four levels identified are: 1) none, 2) some primary school, 3) primary school completed, and 4) secondary school and above.

4. Health Knowledge. We considered health knowledge as an important factor affecting proximate determinants. Two variables used which may relate to child survival interventions were: immunization and the growth monitoring program.

   (a) Ever Heard the Word Immunization: Women were asked whether they had ever heard the word immunization and the use of BCG, DPT, TT, and measles immunization. Because only a few women knew details on each immunization, we considered only the question on ever or never heard as a proxy for understanding the concept of health prevention in general. Thus this variable has two reponse categories.

   (b) Remember current weight of her children: Mothers who answered that their children had ever been brought to a weighing program were asked about the last weight of their children. We expected that a mother's attending the weighing program would at least increase her awareness about the weight of her children, and serve as a proxy for health in general.

5. Occupation.

    (a) Mother's place of work: We classified mothers into categories of mothers who worked inside and outside home. This is more intended as a measure of the mother's time allocated for caring for her children, rather than the monetary earnings from employment.

    (b) Father's occupation: Father's occupation was classified into three categories: 1) not working or staying at home, or working in the private sector without employees, 2) working in the private sector with employees, and 3) working for the government in military or civil services (*Pegawai Negeri and ABRI*). Occupation may relate to the amount of income, but we decided that the social status and gain from other modern health services and information is more important than income.

6. Membership at social organizations and religion. Women were classified according to their membership in social organizations i.e., as a member or nonmember of an existing social organization. Being a member of a social organization may improve access to health services as a result of the diffusion of health information. Women's religion was classified according to Catholic or other.

Macro Variables

1. Health Input and Systems Variables. Some indicators of community utilization of health care were aggregated from individual women's responses concerning their past pregnancies, births, and

children's immunization. Because of distribution of health facilities can be diverse, the measures of access to medical personnel and facilities were also constructed from the community survey.

(a) Prenatal Care Variable: This is the proportion of women in the PHC–CA who visited health care personnel (*doctors or paramedics*) during their pregnancy.

(b) New Born Care Variable: This is defined as the population of children in PHC–CA or village where a medically qualified attendant was present during birth.

(c) Immunization Index: This is defined as the proportion of children in the PHC who received complete immunization.

(d) Family Planning Strength: This is defined as the proportion of MWRA in the PHC–CA who ever used modern contraceptive methods.

(e) Growth Monitoring Index: This is defined as the proportion of households at PHC–CA whose children had ever been weighed in the Center's weighing program.

(f) Medical Access: Access to medical facilities (*clinics or PHC*) is determined in the village survey. The respondent for this survey was the village leader, who is presumably knowledgeable about the community as a whole, and the response were also validated by the leader of interviewer. Medical access variables are distances in kilometers from village to the nearest clinic, PHC, or hospital.

(g) Medical personnel: is defined as the number of thousand population per government medical personnel. For example, one

PHC with 40,000 population and 2 medical personnel will have a medical personnel variable equal to 20.

2. Community development and socioeconomic level. The community background variables which all on their own may affect child health status, here serve as a control variable in order to assess the independent effect of health intervention.

   (a) Urban and rural Status: is a rural or urban village defined by local government.

   (b) School Index: This is defined as the average of distance from the village to the closest primary school.

   (c) Proportion Electricity: This is defined as the proportion of the households in the PHC–CA/village who had electric power available during the survey.

   (d) Food Storage: This is defined as the availability of government food storage/BULOG/KUD at the village where the respondent lived.

   (e) Number of health cadre. Number of population per health cadre may reflect the degree of community participation in health programs. It may also serve as an indicator of how the POSYANDU program had been implemented in this area. However, we could not count total number of health cadre at each PHC rather than the number health cadre trained in the PHC. In such cases we may use this latter variable as the indicator of health input.

   (f) Percent of MWRA as a member of social organization. This is the measure of the degree by which women have opportunity to diffuse their health knowledge through organization activities. These organizations also serve as a social network to distribute health and family planning intervention.

(g) Geographic and Village Conditions. These conditions will be determined according to the land, road, and accessibility from the district or subdistrict. For example, percentage of village at PHC level with asphalt roads is used as an indicator of village development. However one may associate this variable with the geographic accessibility to health.

Chapter 5

CHARACTERISTICS OF THE SURVEYED POPULATION

5.1 INTRODUCTION

This chapter will begin with a brief description of Indonesia and then present the distribution of respondents by selected demographic and socioeconomic characteristics. This chapter also covers some utilization of health services, as well as a comparison with the same information from other sources as a measure of the quality of the data.

5.2 DESCRIPTION OF INDONESIA

5.2.1 Geography

The Indonesian archipelago covers an area of approximately 1.9 million square kilometers. The nation comprises more than 13,000 islands, but only 600 are inhabited. All of the islands lie in the tropical zone with stable year–round temperatures between 25 to 28 degrees celsius. May through October is considered the “dry season”, while the period of November through April is “rainy season”. In eastern part of the country, however, the dry season is longer than the west.

Indonesia consists of 27 geo–political regions called provinces.

These are also sometimes termed as first level regions (*Daerah Tingkat I*). The greater Jakarta, The Special Region of Yogyakarta, and The Special Region of Aceh, all have the status of province. Second–level regions (*Daerah Tingkat II*) comprise districts (*Kabupaten*) and municipalities (*Kota–Madya*). By no means are all cities of appreciable size called municipalities, hence Kabupaten can themselves have a substantial urban population. Kabupaten are divided into subdistricts (*Kecamatan*) which in turn are broken down into the lowest formal administrative units called villages (*Kalurahan*). The term "village" in Indonesia tends to be used loosely to mean either a village complex (*one administrative unit*) or one of its constituent hamlets (*Dukuh*). All together there are 300 districts, about 3,500 subdistricts, and more than 66,000 villages (*See Figure 4.1 in chapter 4*)

5.2.2 Demographic Figures of Indonesia

Population Size and The Growth Rate

In terms of the size of its population, Indonesia stands fifth in the world after China, India, The Soviet Union, and the United States of America (*the USA*). Total population was estimated in the intercensal Population Survey of 1985 (*1985 SUPAS*) to have reached 163.9 million persons. The population census of 1961, 1971, and 1980, recorded a total population of 97 million, 119.2 million, and 147.5 million persons respectively (*Hull and Hull, 1984*). The population grew at annual an rate of 2.06 percent from 1961 to 1971, and the growth rate increased to 2.32 percent from 1971 to 1980; it was recently estimated to have decreased to 2.13 percent from 1980 to 1985 (*CBS, 1987*). At this rate, the population of Indonesia will be 211 million in the year 2000 (*UNFPA, 1988*). Table 5.1 (*page 135*) shows some demographic

Table 5.1: DEMOGRAPHIC FIGURES OF INDONESIA

POPULATION TOTAL (*000*):	
Total	166,464
Sex Ratio (*per 100 females*)	99.2
Percent urban	25.3
Projected in the year 2000	208,329
FUNCTIONAL AGE GROUP (*Percent*):	
Young Child: 0-4	13.4
Child: 5-14	25.3
Youth:15-24	20.2
Elderly: 65+	3.6
Women: 15-49	24.8
MEDIAN AGE (*years*)	20.2
DEPENDENCY RATIOS(*per 100*):	
Total	73.0
Aged:0-14	66.8
Aged:65+	6.2
AGRICULTURAL POPULATION DENSITY:	
(*per hectare of arable land*)	3.89
POPULATION DENSITY (*per sq km*)	87.0
CRUDE BIRTH RATE (*per 1000*)	27.4
CRUDE DEATH RATE (*per 1000*)	11.2
NET MIGRATION RATE (*per 1000*)	0.0
TOTAL FERTILITY RATE:(*per woman*)	3.3
GROSS REPRODUCTION RATE:(*per woman*)	1.61
NET REPRODUCTION RATE:(*per woman*)	1.30
INFANT MORTALITY RATE:(*per 1000 births*)	84
LIFE EXPECTANCY AT BIRTH (*years*):	
Males	54.6
Females	57.4
Both sexes	56.0
GNP PER CAPITA	
(*US dollars, 1986*)	490

Sources: UNFPA, 1988: Inventory of Population projects in developing countries around the world and CBS, 1985 SUPAS DATA

facts about Indonesia.

Population Distribution and Density

The Indonesian population has some distinct characteristics. It is unevenly distributed among islands and provinces. More than 60 percent of all Indonesians live on Java Island, which has only about 7 percent of the total land area of the country.

In 1961, 65 percent of the total population were residing in Java

Island. In the 1971 census, this percentage showed a decline to 63.8 percent, and in the 1980 census it had declined to 61.8 percent. Variation in the population distribution makes the density of population per square kilometer vary between areas. For example, in 1980 population density in Java was 690, Sumatra was 59, Sulawesi was 55, Kalimantan was 12, and for the other islands was 5 persons per square kilometer. The diversity of this population distribution is one of the obstacles in the distribution of the health services in Indonesia.

Fertility

The total fertility rate (*TFR*) is a very helpful summary indicator of fertility level in the country. Results of the 1971 census show that the TFR was 5.6 in the mid–1960s. The 1985 SUPAS data indicated a TFR of 4.1 children per woman for the period 1981–1984. These two results suggest that in less than 15 years there was a decline of 28 percent. However, there is a substantial variation in TFR among the major islands of Indonesia, even within Java island. For example, the West Java province has a TFR of 4.3, while Special Territory of Yogyakarta province has a TFR of 2.9 children per woman. The highest TFR in Indonesia (*5.7*) occurs in the provinces of West Nusa Tenggara.

Mortality

Lacking data from the registration system, IMR and other mortality indices have traditionally been estimated indirectly from census or survey data. While mortality rates in Indonesia, particularly for infants and children, remain relatively high compared to the neighboring ASEAN countries, data show that there has been a significant decline in mortality (*Hull and Hull, 1984; McDonald, 1980*) Between

1971–1980, the crude death rate (*CDR*) was estimated as declining from 18.7 to 12.5 per 1,000 population. This number reflects a 33 percent decline in the CDR within a 10–years period. A recent estimate of the CDR is 11.2 per 1,000 population.

Based on the 1961 census, the IMR was estimated to be 150 deaths per 1,000 live births. This figure dropped to 142, according to the 1971 census, and decline to 112 per 1000 live births in 1980. A recent indirect estimate from the 1985 SUPAS shows the IMR declined to 84 per 1000 live births. This decline may reflects effort in the field of primary health care, especially those designed to reduce infant and child mortality. It should be noted, however, that there was substantial variation in the IMR even within Java island. For example, data from the 1985 SUPAS showed the IMR of Central Java Province about two times higher than the neighboring Province of Yogyakarta (*73 versus 35 per 1,000 live births*).

As in many other LDCs, neonatal mortality still contributes about half of total infant mortality. Furthermore, the major cause of infant and child mortality in Indonesia are still synergetic effects of malnutrition, diarrhea, and respiratory infection. Recent household survey showed that the ten most prominent causes infant deaths in descending order, are as follows: neonatal tetanus, perinatal causes, diarrhea, acute respiratory infections, measles, nervous system disorders, congenital anomaly, diphtheria and whooping cough, anemia and malnutrition, and other causes (*Budiarso et al., 1986*).

Nutritional Status Indicators In Indonesia

The recent data available on nutritional status come from the 1986/1987 National Socioeconomic Surveys. The indicator of nutritional status was calculated based on the data of $20,000 - 30,000$ children from 27 provinces. The calculation used weight for age and the Harvard standard as a reference value. The number showed that 40.2 children fall in the ranges of $70 - 79$ percent median Harvard standard. Almost one in ten children (*9.8 percent*) were in the ranges between $60 - 69$ percent while 1.3 percent fall in the ranges below 60 percent of the median Harvard Standard (*Department of Health and CBS, 1987*). Less than half of the young children in Indonesia are in the normal range categories (*80 percent and above*).

Besides the high level of prevalence, a substantial variation between provinces also exists. There is also variation between urban and rural settings. These findings were supported by the results of the national household survey, although the indicators were reported based on the weight–for–height data (*Budiarso et al., 1988*). Only the previous study by Karjati et al. (*1978*) reported the prevalence of growth faltering based on more complete indicators, including height for age. It should be noted that Kardjati's study was also considered to have done relatively better on age reporting compared to other reports.

5.2.3 Social Economic Development of Indonesia

In Indonesia, development programs are implemented in five–year stages, or so called "Rencana Pembangunan Lima Tahun" (*REPELITA*). In the first REPELITA ($1970 - 1974$), development plans favored strong support for the promotion of agricultural products. Recently, the focus of development is placed on industry that produces export commodities.

In 1982, the World Bank gave a figure of US$580 for the gross national product per capita. After substantial devaluation of the rupiah (*the Indonesian currency*) in September 1986, per capita annual income is now calculated at about US$490. Between 1977 and 1985 per–capita income grew in money terms at about 20 percent per annum. However, more than half of this number can be attributed to the inflation rate.

Since 1985, with the decrease in oil prices in the world market, the pace of development has been slowing down. The decline in oil revenues is making it difficult to satisfactorily sustain extensive development of the country infrastructure, including the health sectors.

The Indonesian educational system has undergone substantial improvements. The 1985 SUPAS data show that the literacy rate of persons 10 years and older was 74 percent for females and 88 percent for males. Between 1980–1985 the percentage of primary school graduates increased from 21 percent to 27 percent, whereas persons who completed high junior school and higher increased from 11 to 16 percent. It should be noted that at all levels the improvement in female education has been greater than for male. This improvement may contribute to the increase in female labor force participation in Indonesia; in 1980 it was 32.4 percent, and by the year 1985 it was 37.6 percent.

5.2.4 Population And Health Policies And Programs

The objectives of Indonesian Population Policy are to reduce population growth, mainly by family planning programs, to achieve a more equitable pattern of population distribution, and enhances job prospects and living conditions. The current five–year plan (*Repelita–IV 1985/1986–1989/1990*) calls for a holistic and integrated approach to population issues and assigns considerable importance to the community and non-governmental organizations in initiating and implementing population programs. The philosophy behind this approach focuses on implementing population-oriented development in which population is both the object and the subject of development.

To deal with size and age structures of the population, the government targeted the annual population growth rate to 1.5 percent by 1990. Besides Family Planning (*FP*), policies focused on rural development. Promoting the status of women in general and raising the age at marriage are also major efforts in achieving the current target. However, the strongest emphasis has been placed on family planning programs.

Indonesian Family Planning (*FP*) activities were initiated in 1956 by a private organization, working under the auspices of the International Planned Parenthood Federation. In 1968, the government established a National Family Planning Institute, which in 1970 was recognized as the National Family Planning Coordinating Board (*NFPCB*). This program moved rapidly to cover Java and Bali with clinics and local contraceptive depots, and to set up an elaborate promotional campaign. The success of the program can be attributed to government backing and assistance, including from the local civil administrations in reaching target acceptors (*Warwick, 1986*). It was only in 1974 that the target program was extended to the more populous provinces outside Java and Bali, and in 1979 to the remaining provinces including the Nusa Tenggara Timur (*NTT*). Most of the distribution of modern contraceptives in Indonesia relies on program supplies. Only recently has the government started examining the potential of the private sector in contraceptive supplies (*Sujono, 1988*).

Reducing morbidity and mortality rates is part of the government's welfare policies. A current policy includes strengthening the health infrastructure by expanding health service coverage and developing local community participation in providing preventive and curative care, mainly through the development of PHC and POSYANDU. Programs are primarily directed toward increasing the survival of children aged under 5, through intensive efforts in child survival intervention: growth monitoring, oral rehydration therapy, breast feeding promotion, and immunization. These efforts are enhanced by two other related activities: family planning programs and an effort to increase a female education.

Government quantitative targets are to reduce the CDR to 10 per 100 and the IMR rate to 35 per 1000 by 1990. The policy focuses on children under age five and pregnant women in rural areas. The REPELITA IV calls for trained personnel to assists 60 percent of all deliveries by the end of 1989, and 65 percent of pregnant women to have an average of four prenatal visits to a health facility.

5.3 DEMOGRAPHIC DATA OF THE STUDY POPULATION

5.3.1 Age and Sex Composition

Collecting data on age is always difficult in a less advantaged society, including in this study. Our problem arose because of the facts that: 1) a large proportion of the population does not know their date of birth, and 2) some age information was given by the head of the household, except for children and married women of reproductive age (*MWRA*).

When respondents were asked to estimate the ages of other members of household they often chose numbers ending with 0 or 5 (*digit preference on 0 or 5*). In some other cases, women who did know their

Table 5.2: PERCENT DISTRIBUTION OF SAMPLED POPULATION BY AGE GROUP CHARACTERISTICS FROM SURVEY AND SUPAS–1985

Age	TCS, 1988†			Sex	SUPAS, 1985‡			Sex
Group	Female	Male	Total	ratio	Female	Male	Total	ratio
0–4	12.8	12.9	12.9	1.007	14.4	15.9	15.1	1.085
5–9	16.3	16.4	16.4	1.007	13.9	15.1	14.5	1.069
10–14	13.0	13.1	13.1	1.006	11.7	13.0	12.4	1.091
15–19	9.5	9.0	9.3	0.956	9.3	9.2	9.2	0.970
20–24	7.9	6.4	7.1	0.807	8.9	7.1	8.0	0.781
25–29	8.4	6.4	7.4	0.770	8.4	7.0	7.7	0.827
30–34	6.5	6.3	6.4	0.979	6.1	5.8	6.0	0.946
35–39	5.6	6.0	5.8	1.086	5.5	5.5	5.5	0.985
40–44	4.1	4.7	4.4	1.133	4.8	4.5	4.7	0.926
45–49	3.7	5.2	4.5	1.146	4.3	4.5	4.4	1.031
50–54	1.8	3.3	2.6	1.902	3.7	3.5	3.6	0.949
55–59	5.7	3.8	4.8	0.667	3.0	2.9	3.0	0.959
60–64	1.8	2.7	2.2	1.664	2.4	2.2	2.3	0.937
65+	2.8	3.8	3.3	1.352	3.5	3.7	3.6	1.030
Total	100.0	100.0	100.0	1.004	100.0	100.0	100.0	0.986
N	19,632	19,703	39,335		1,541,538	1,519,706	3,061,244	

Note: *†Our Timor Child Survival Study, 1988 ‡The 1985–Intercensal Survey.*

exact age for some reason intentionally reported a higher or lower age. For example, unusual frequencies were found among females in the age group 50–54 and 55–59 years in Table 5.2 (*page 142*). The percentage of the female population for age groups $50-54$ and $55-59$ years are 1.8 and 5.7 percent respectively. Data suggest that women aged between $50-54$ years tend to report themselves to be older since percent of age group $55-59$ years is almost 3 times greater than the age group $50-54$ years. This artefact may be strongly related to the fact that women aged 55 or above were not asked about their reproductive history, so by giving her age to be more than 55 years, she would not need to answer further questions. [1] As shown on the population pyramid in Figure 5.1(*page 144*), the age distribution of females between $50-59$ is rather peculiar compared to the findings from SUPAS,

[1]We anticipated the occurrence of this phenomena. In order to obtain correct age below 50 years, we interviewed all of married women below age 55 years. Therfore although these women were interviewed in detail; our interest lies in MWRA (ages below 50).

1985 data in Figure 5.3(*page 145*). Our population pyramid suggests that there is a declining proportion of children under 5 compared to the age group $5-9$ years. Although it may indicate a recent fertility decline, one cannot rule out the possibility of an age misstatement, for reasons similar to the women 50 years old and over. However, our examination of the age distribution by single year among children under 15 does not invite a serious suspicion (*not shown*).

There are some other interesting figures to note from the age–sex pyramid. First, the target population is "young", which means that the percentage of children under 15 years is still above 40 percent. It was 42.4 percent in our survey and 42.8 percent in the 1985 SUPAS data. Secondly, the number of males compared to females by age appears to be well above 1.0. This is unusual, since a sex ratio below 1.0 was found in the 1985 SUPAS as well as in previous censuses in 1961, 1971, and 1980 (*Gardener and Oie, 1986*).

Accurate data on age of surviving children under 5 years are needed for the nutritional status assessment. More than 80 percent of the children have date of birth information reported by the mother. About 79 percent of these were taken from the birth certificates, and 43 percent of these were confirmed by the baptism cards. Less than 17 percent of the data was reported without knowing an exact date of birth, except the child's age to the month. When only the exact day was missing, age was calculated by assuming that birth occurred in the middle of the month. The age distribution suggests that age information does not suffer from age misreporting. As we can see from the histogram on Figure 5.3(*page 145*), there is no serious age heaping for children under 5 years, although age heaping does not completely disappear at age 24, 36, and 48 months.

Figure 5.1: POPULATION PYRAMID OF STUDY POPULATION, TIMOR, INDONESIA, 1988

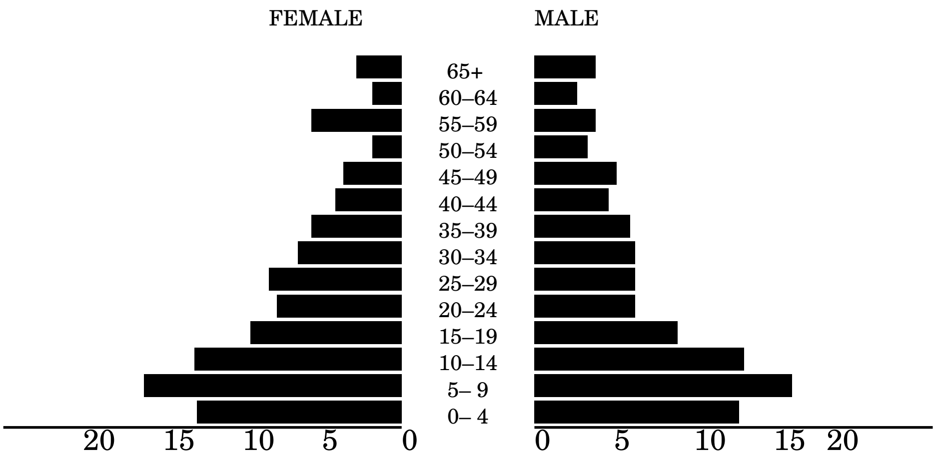
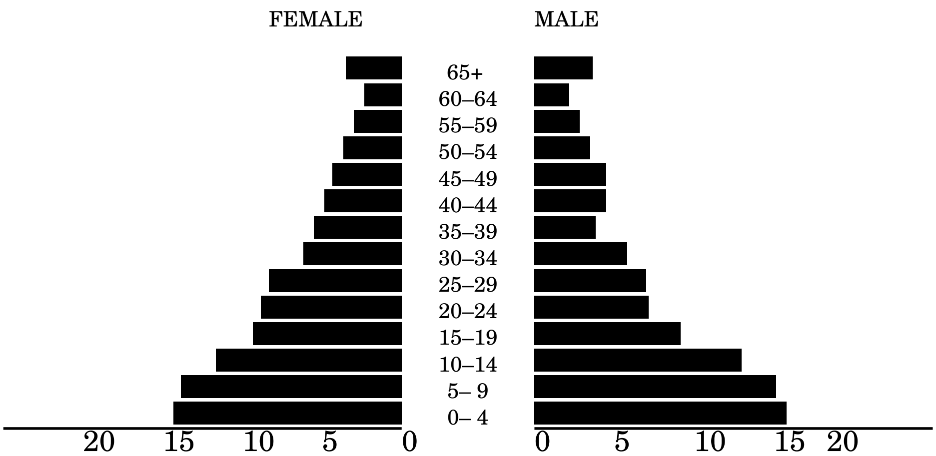
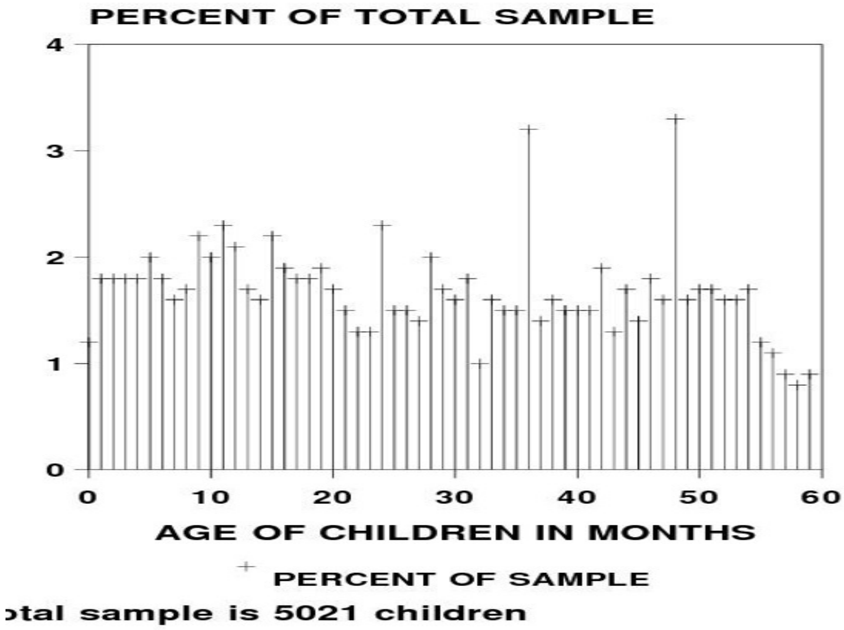


Figure 5.2: POPULATION PYRAMID OF WEST TIMOR PROVINCE ACCORDING TO SUPAS DATA, 1988



Source: Kantor Wilayah Statistik, Propinsi NTT, 1987

Figure 5.3: Age Distribution of Under 5 Children in months



5.3.2 Social Economic Status of The Household

Table 5.3 (*page 146*) shows the distributions of all surveyed population by education and other selected characteristics. The numbers show the higher percentage of young population who have "a primary education or higher", and the higher percentage of older population who have "no education".

A similar pattern for MWRA is also shown in Table 5.4 (*page 146*). This inverse relationship between age and education is evidence of the improvement in educational attaintment.

Table 5.5 (*page 147*) shows the variation in achieved levels of education in four districts. Variation among districts suggests the level of education in Kupang is higher compared to the other three districts. More than 20 percent of the population sampled has "a secondary ed-

Table 5.3: PERCENT DISTRIBUTION OF SAMPLED POPULATION BY AGE–GROUP AND EDUCATIONAL CHARACTERISTICS, TCS 1988

Age Group	None	Some primary	Primary complt.	Second-ary sch.	High Sch. or more	Total pct.	Number of cases
10–14	3.6	82.9	3.8	9.0	—	100.0	5136
15–19	5.6	30.0	25.5	24.9	13.9	100.0	3641
20–24	11.3	19.4	38.1	10.8	20.4	100.0	2804
25–29	17.6	19.9	41.9	8.1	12.5	100.0	2914
30–34	21.0	20.3	38.7	7.7	12.4	100.0	2513
35–39	28.3	21.9	34.7	5.7	9.4	100.0	2290
40–44	38.5	20.8	27.2	5.2	8.3	100.0	1732
45–49	45.1	18.7	25.8	3.3	7.0	100.0	1761
50–54	51.4	16.7	22.6	3.2	6.1	100.0	1004
55–59	67.9	12.6	15.8	1.3	2.4	100.0	1879
60–64	69.2	13.8	14.4	.5	2.2	100.0	882
65+	75.1	10.1	12.0	1.2	1.6	100.0	1291
Total	26.0	31.7	24.8	8.9	8.6	100.0	27847

Table 5.4: SAMPLED EVER MARRIED WOMEN AGES 15–49 BY AGE GROUP AND EDUCATIONAL CHARACTERISTICS, TCS 1988

Age Group	None	Some primary	Primary complt.	Second-ary sch.	High Sch. or more	Total pct.	No. cases
15–19	13.2	23.5	44.1	11.8	7.4	100.0	68
20–24	16.0	17.4	51.4	8.9	6.6	100.0	730
25–29	20.5	18.6	46.9	7.1	7.0	100.0	1346
30–34	26.8	17.8	41.5	7.0	7.0	100.0	1217
35–39	35.1	20.6	35.3	4.3	4.7	100.0	1085
40–44	48.2	19.1	25.5	4.1	3.1	100.0	777
45–49	54.8	17.1	20.7	2.9	4.5	100.0	696
TOTAL	31.5	18.6	38.2	6.0	5.7	100.0	5919

Table 5.5: PERCENT DISTRIBUTION OF SAMPLED POPULATION AT EACH DISTRICT BY EDUCATIONAL CHARACTERISTICS, TCS 1988

District	None	Some primary	Primary complt.	Secondary sch.	High Sch. or more	Total pct	No. cases
KUPANG	29.7	29.2	20.3	9.5	11.3	100.0	7393
TTS	42.2	34.6	11.5	6.1	5.6	100.0	10144
TTU	38.5	30.7	23.1	4.4	3.3	100.0	13311
BELU	43.1	30.3	18.7	4.5	3.4	100.0	8514
Total	38.3	31.6	17.6	6.3	6.2	100.0	39362

Table 5.6: SAMPLE OF MWRA BY DISTRICT AND EDUCATIONAL CHARACTERISTICS, TCS 1988

District	None	Some primary	Primary complt.	Secondary sch.	High Sch. or more	Total pct.	No. cases
KUPANG	15.3	19.3	45.3	10.3	9.7	100.0	1485
TTS	44.0	22.9	22.5	4.6	6.0	100.0	1932
TTU	27.8	13.7	50.8	4.8	2.8	100.0	1383
BELU	35.9	16.1	40.6	3.9	3.5	100.0	1119
Total	31.5	18.6	38.2	6.0	5.7	100.0	5919

ucation or more", while for the same numbers for TTS, TTU, and Belu are less than 12 percent. A similar pattern is shown by MWRA at Table 5.6 (*page 147*).

Working status was classified according to six categories of activities performed within the last two weeks. Subjects were classified as follows: 1) not working, 2) working in a private job without any staff, 3) working in a private job with staff, 4) a blue collar worker (*Buruh*), 5) a white collar worker (*pegawai negeri or ABRI*), and 6) working for the family (*including housewives*).

Table 5.7 (*page 148*) shows the distribution the whole surveyed population according to their ages and working status. Percentages for the sample working in the private sector with help fall below 10 percent. The smaller percentage of blue collar workers in NTT is mainly due to the fact that the industrial sector in this province is relatively small. The higher percentage of those working without help is at-

Table 5.7: PERCENT DISTRIBUTION OF SAMPLED POPULATION BY AGE–GROUP AND WORKING STATUS, TCS 1988

Age Group	None	Priv. no hlp	Priv. with hlp	Blue collar	White collar	Work for HH	Total pct.	No. cases
15–19	63.0	2.5	1.2	.3	.1	32.9	100.0	3641
20–24	19.4	11.8	2.4	1.9	2.1	62.4	100.0	2804
25–29	5.3	26.2	4.7	2.7	4.9	56.2	100.0	2914
30–34	1.0	34.9	5.9	2.5	7.6	48.1	100.0	2513
35–39	.8	38.1	7.9	1.9	7.0	44.1	100.0	2290
40–44	.5	38.7	9.6	2.0	7.0	42.0	100.0	1732
45–49	.7	42.4	13.1	1.3	6.5	36.0	100.0	1761
50–54	1.4	46.0	12.8	1.1	6.6	32.2	100.0	1004
55–59	1.4	32.5	11.4	.8	2.1	51.7	100.0	1879
60–64	5.3	45.7	11.9	2.6	1.0	33.4	100.0	882
Total	15.2	28.4	6.9	1.6	4.4	47.5	100.0	
N	3147	5832	1422	338	907	9774	100.0	21420

Table 5.8: PERCENT DISTRIBUTION OF SAMPLED POPULATION BY DISTRICT AND WORKING STATUS, TCS 1988

Dis-trict	None	Priv. no hlp	Priv. with hlp	Blue collar	White collar	Work for HH	Total pct	No. cases
KUPANG	20.7	24.5	4.3	3.8	6.4	40.3	100.0	5685
TTS	14.5	29.7	4.0	.8	3.9	47.0	100.0	7253
TTU	9.2	23.0	11.4	.9	3.6	51.9	100.0	4604
BELU	12.9	31.4	9.2	.6	2.5	43.4	100.0	3878
Total	15.2	28.4	6.9	1.6	4.4	47.5	100.0	
N	3147	5832	1422	338	907	9774	100.0	21420

tributed to traditional farming, which is usually done by the members of the household only. This also contributes to the higher of percentage in the sample of those who work for the household, despite a substantial fraction of women are only housewives.

Table 5.8 (*page 148*) shows the distribution the whole surveyed population between the ages $15 - 64$ by occupational status and region. The Kupang district has a higher percentage of white collar workers compared to other districts. The higher percentage of non–working status people in Kupang may reflect the number of children who are still in school.

Sources of income for the household were classified according to four sectors: 1) nonagriculture, 2) only agriculture, 3) mixed but mainly agriculture, and 4) mixed sectors but mainly nonagriculture. Only 11 percent of the household had a source of income from a non–agriculture sector, and the three other sectors were 77.4 percent, 6.5 percent, and 5.1 percent respectively. Not all farmers own land. Only 87.3 percent of households with economic resources from an agriculture sector own land, and on average their land area is 0.85 hectares, and the median is 1.5 hectares (*Figure 5.4 page 150*).

The total of household cash expenditures was calculated based on the last three months expenditures. On average, the mean of total cash expenditures is Rp. 52,398.– and the median is Rp. 36,000.– (*$1=Rp. 1,750.–*) per month. Most of these expenditures were mainly for buying food, and on average Rp. 28.086.– (*median Rp. 35,000.–*) is spent on food per month. Only a small percentage of the household expenditures was used for curative or preventive illness control. On average Rp. 1,583.– (*median Rp. 1,000.-*) was spent for this "health expenditure per month". However, only 72 percent of population spent their money on health–related expenditures, and 28 percent said they did not spend any money on the health–related expenditures within the last of three months. For each household, on average, the food expenditure is about 59 percent of the total cash expenditures, and health expenditure is about 4 percent of the total cash expenditure. Both numbers do not vary significantly between urban and rural households; the difference is less than 2 percent (*See Figure 5.5 page 150*).

Table 5.9 (*page 151*) shows a household distribution by household goods, and animal livestock owned. Overall, less than 17 percent of our sample own clocks, a sewing machine or radio, and less than 10 percent own a kerosine stove, bicycle, television, motorcycle, or car.

Figure 5.4: Pie Diagram on Percentage of Sources of Income

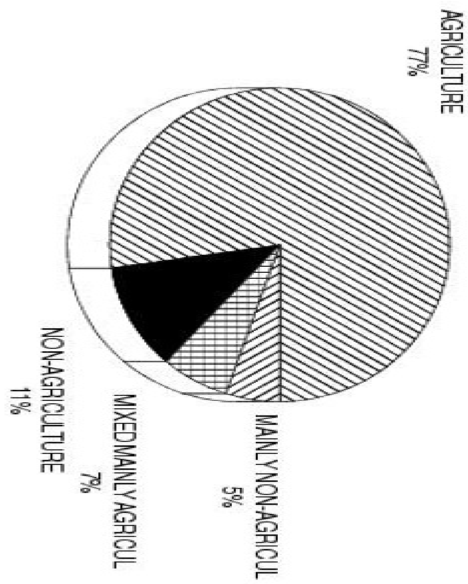


Figure 5.5: Pie Diagram of Percentage of Cash Expenditures

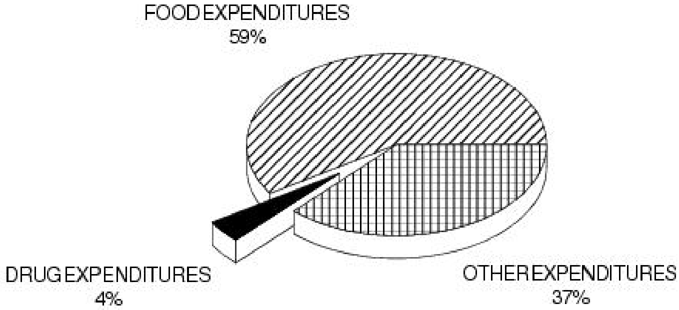


Table 5.9: PERCENTAGE OF SAMPLE WHO OWN SOME HOUSEHOLD AMENITIES AND ANIMAL LIVESTOCKS BY DISTRICT AND RURALITY

Household	District of:				Region		Pct.	No.
ownership	Kupang	TTS	TTU	Belu	Urban	Rural	Total	cases
AMENITIES								
Stove	23.0	6.0	3.7	3.1	52.9	3.7	9.1	729
Gas Lamp	29.1	28.8	27.9	16.9	20.2	27.3	26.5	2116
Clock	27.5	9.8	7.2	5.6	53.3	7.8	12.8	1022
Table	88.0	79.4	80.0	51.6	86.8	74.9	76.7	6114
Bicycle	4.2	2.3	1.3	2.4	7.5	1.9	2.5	203
Sewing	21.6	8.8	9.1	7.7	49.7	7.2	11.8	943
Radio	31.0	13.3	12.2	10.1	56.8	12.0	16.9	1348
TV	14.5	5.1	3.1	1.8	41.9	2.0	6.3	505
Motor	7.4	2.6	1.9	2.3	37.2	1.5	3.6	285
Car	2.4	.7	.5	.4	5.6	.4	1.0	79
LIVESTOCKS								
Cow	42.8	53.1	49.9	46.7	14.8	96.7	48.6	3877
Carabao	1.2	1.6	1.4	3.7	.5	2.0	1.8	144
Horse	14.0	13.4	12.4	22.9	1.9	16.6	15.0	1195
Pig	57.9	79.8	77.4	73.6	34.8	77.4	72.7	5792
Goat	15.2	16.7	23.0	15.5	8.2	18.7	17.6	1401
Goose	1.7	1.8	2.0	2.3	2.6	1.8	1.9	152
Chicken	56.9	79.4	63.4	77.1	30.0	74.5	69.6	5546

There is a significant difference between Kupang and the other three districts. Substantial differences also occur between urban and rural households. Except for the gas lamp (*Petromax*), urban households are more likely than rural households to have the others amenities. As these amenities can be used as economic indicators, one may say that urban households tend to be better off economically than rural households.

Differences among districts in the proportion of households who have animal livestock (*cow, carabao, horse, lamb/goat, pig, goose and chicken*) vary without an obvious pattern. Except for the horse, the district of Kupang has a smaller percentage of households with other animal livestock. However, there is a substantial difference between urban and rural. Households in rural area are more likely to have the animal livestock. As well as household amenities, one may use this

Table 5.10: PERCENTAGE OF HOUSEHOLDS ACCORDING TO HOUSING CONDITIONS BY DISTRICT AND RURALITY

Household ownership	District of: Kupang	TTS	TTU	Belu	Region Urban	Rural	Pct. Total	No. cases
LIGHTING								
Electric	29.9	6.6	3.7	3.9	70.6	3.9	11.2	896
Gas Lamp	2.6	5.4	5.4	3.6	6.5	4.1	4.4	349
Kerosine	67.5	88.0	90.9	92.5	22.9	92.0	84.4	6725
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	7970
FLOOR								
Concrete	36.3	12.4	13.6	21.2	66.3	14.4	20.2	1611
Non-Concrete	63.7	87.6	86.4	78.8	33.7	85.6	79.8	6359
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	7970
WALL								
Concrete	37.8	14.4	23.3	8.5	54.5	17.2	21.3	1697
Bamboo	8.5	24.6	7.4	9.1	1.7	15.2	13.7	1095
Leaf	53.7	61.0	69.3	82.4	43.8	67.8	65.0	5178
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	7970
ROOF								
Genteng/ Zinc/Asbes	59.7	22.2	30.8	35.7	83.4	30.1	36.0	2866
Leaf/Grass	40.3	77.8	69.2	64.3	16.6	69.9	64.0	5104
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	7970

information as an economic indicator, especially in the rural area.

5.3.3 Household's Environmental Conditions

Table 5.10 (*page 152*) shows the distribution of households by housing condition. Housing condition was distinguished according to the source of lighting, and floor, wall, and roof materials. The source of lighting is usually kerosine (*84.4 percent*), followed by electricity (*11.2 percent*) and gas–lamp/petromax (*4.4 percent*). Differences among districts in the proportion of households who use electricity are very significant, with the Kupang district being the highest. In rural areas, lighting from kerosine is most common, while electricity is more common in urban area (*70.6 versus 3.9 percent*).

Floors are usually made from non–concrete materials (*about 80* *percent*), such as wood, bamboo, and soil. Only about 20 percent of houses in NTT have concrete floor material. Houses in the Kupang district are more likely to have a concrete floor than houses in the other three districts. Houses in urban areas are also more likely to have concrete floors than those in rural areas.

Many houses in the province of NTT still use leaf and grass wall and roof materials (*65 percent for wall and 64 percent for roofs*). Only 21 percent of all of houses have concrete walls and 15 percent are of bamboo materials. Urban houses are more likely to have concrete walls than rural houses. Roofs in urban area are more likely to be made from “genteng”(*clay–tile*), zinc, or asbestos materials than in rural areas. In general housing conditions in the Kupang district are more likely to be better than in the other three districts. Despite the facts that housing materials can be related to environmental conditions, one may also use this as a socioeconomic indicator of the household,— in the other words, the better the housing conditions the better the socioeconomic of the household.

The “crowding index” (*measured by the total area of the house divided by total members of the household*) is more frequently used as an indicator of environmental conditions. On average the crowding index in the NTT province is about 9.7 square meters per person. In rural areas this index is 9.5, while in urban areas the index is 11.5 square meters per person. Clearly there is a difference between urban and rural areas in terms of “a crowding index”. The Kupang district has a crowding index of 11.2 square meters per person while TTS, TTU, and BELU districts are 9.1, 9.3, 9.3 respectively. Again, the Kupang district has less crowding index compared to the other three districts.

Table 5.11 (*page 154*) shows the distribution of samples by san-

Table 5.11: PERCENTAGE OF THE HH ACCORDING TO WATER AND SANITATION FACILITY BY DISTRICT AND RURALITY

Household ownership	District of:				Region		Pct. Total	No. cases
	Kupang	TTS	TTU	Belu	Urban	Rural		
DRINKING								
Pipe	17.0	6.3	15.5	8.8	49.1	6.9	11.6	921
Well	44.5	9.7	26.8	35.5	29.0	26.8	27.0	2125
Spring	27.8	78.3	48.5	51.2	18.1	58.3	53.9	4295
River/other	10.7	5.7	9.2	4.5	3.8	8.0	7.5	602
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	7970
BATHING								
Pipe	17.1	6.1	15.2	8.6	48.4	6.9	11.4	911
Well	43.8	9.4	25.4	36.1	28.9	26.2	26.5	2112
Spring	26.6	70.8	41.1	50.3	17.7	53.0	49.1	3916
River/other	12.5	14.0	18.3	5.0	5.0	13.9	13.0	1031
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	7970
LATRINE								
Septic	15.9	5.5	2.9	4.8	34.8	4.0	7.3	585
No-Septic	66.5	91.9	91.2	58.2	55.0	82.4	79.4	6328
River/other	17.6	3.3	5.9	37.0	10.2	13.6	13.3	1057
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	7970

itary conditions in the household environments. This table also displays the distribution of households by sources of water for drinking bathing, washing, cooking, and for other uses according to districts and urban rural regions. Only 11.6 percent of all households get their drinking water from pipe water, 27 percent from a well, and 7.5 percent from rivers. Most get water for drinking from springs (53.9 *percent*). Variation on the water supply between districts also exists. These data shows that the Kupang district has a better water supply than the other three districts. This figure also varies between urban and rural households. Urban households are more likely than rural households to drink pipe or well water, whereas rural households depend mostly on an artesis.

The same table demonstrates that the sources of drinking water do not differ from that for washing, bathing, cooking, and other uses. This figure also varies between urban and rural residence, and it shows that the Kupang district is better off than the other three districts. It should be noted, however, that finding ground water is very difficult, since the land on Timor Island is mostly composed of coral material. The short rainy season may also contribute the shortage of water supply in NTT. So even though they have a water supply facility, it does not mean that they receive sufficient water supply. Indeed water supply is a serious problem in many areas of NTT.

In this sample, 13.3 percent of households do not have toilet facilities. They are using either the river or a garden as the toilet facility. Although most have sanitary facilities, latrines with septic tanks are rare (*79.4 percent of households with latrines do not have a septic tank*). Only 7.3 percent of sanitary facilities have a septic tank. There are substantial differences in toilet facilities between urban and rural areas. In urban areas, about 35 percent of sanitary facilities have a septic tank, while in rural areas the number is only 4 percent. There is no sharp difference in the number of households using a river or garden as a toilet facility. Again in terms of a toilet facility with a septic tank, the district of Kupang is better supplied than the other three districts.

5.4 HEALTH AND FAMILY PLANNING SERVICES

5.4.1 Household Ownership of Modern Drugs

Table 5.12 (*page 156*) displays the availability of selected modern and traditional drugs within households at the time of survey. The use of soap as a measure of personal hygiene is also presented in this table. Except for the analgesic cream (*10.7 percent*), the proportion of households having modern drugs is below 10 percent. Urban households

Table 5.12: PERCENTAGE OF THE HH WHO OWN SELECTED DRUGS AND SOAP BY DISTRICT AND RURALITY

Household item	District of:				Region		Pct.	No.
	Kupang	TTS	TTU	Belu	Urban	Rural	Total	cases
Oralit	5.6	2.8	3.4	5.5	8.9	3.6	4.1	329
Anti-diarrhea	3.9	1.1	1.5	2.2	7.2	1.4	2.1	164
Anti-pyretic	7.2	4.1	4.1	5.6	16.0	3.8	5.1	409
Anti-biotic	3.8	3.7	3.5	2.6	10.6	2.6	3.5	279
Anti-malaria	3.5	1.9	1.8	2.2	7.6	1.7	2.3	184
Other pill	4.2	3.5	5.6	2.5	10.7	3.2	4.0	317
Cream relaxant	25.2	4.4	3.2	12.6	22.7	9.3	10.7	855
Traditional	1.9	1.8	.6	3.1	2.5	1.7	1.8	141
Soap	61.6	30.3	39.0	55.8	91.0	39.0	44.7	3561

are much more likely than rural household to have “Oralit”, anti–diarrheal drugs, anti–pyretics, anti–biotics, anti–malarials, cream analgesics, and other pills. In terms of percentages, the district of Kupang is a little higher than the other three districts. The difference between urban and rural on the availability of traditional drugs is very small. It should be noted that availability of “Oralit” and other similar brands is very low (*about 4 percent*), despite government efforts to promote its distribution in the rural areas. However, we did not collect information about the use of home–made “sodium–sugar fluid” or “larutan gula–garam” as an alternative for “Oralit” which has also been promoted by the government.

Less than half of rural households had soap at home. The figure also show that the households in Kupang and Belu are more likely to have soap at home than in the TTS and TTU districts. One may use this number as an indicator of personal hygiene, and data suggest that personal hygiene may still a serious problem in this province.

5.4.2 Variation in Preventive and Curative Illness Control

Data collected from 5,021 children show the variation in use of preventive and curative illness controls between provinces in NTT. Table 5.13 (*page 158*) displays the percentage of children whose mothers received preventive and curative illness control during pregnancy and delivery, as well as immunization received. Children's attendance at the center weighing program (*Pusat Penimbangan Bayi*) is also presented in Table 5.13. Notice that all the information is based on interviews as well as existing records kept within households, such as the growth card and immunization card. It implies that validity of their information should not be regarded as perfect , even though this is the best what we can do on this retrospective survey.

To determine the reliability of immunizations reported, we calculated a coefficient agreement between the number reported to have given BCG and the number of BCG scars found during examination. Among 4,754 children examined, 34 percent were reported as having been given BCG. Among children reported to have been given BCG, 65.7 percent of them had a positive BCG scar, and while 14.6 percent of children who had not received BCG reported had a positive BCG scar. Coefficient Kappa statistics is found equal to 0.52 (*standard deviation=0.0144*), which suggests an acceptable agreement between report of having been given BCG and probable effectiveness of BCG vaccine (*positive BCG scar*) (*Fleiss, 1981*).

Besides the immunization of children, mothers were asked whether they had received antenatal care (*ANC*) during pregnancies for each child, as well as a tetanus toxoid immunization during pregnancy. On average, 57 percent of mothers had received ANC. The TTU district

Table 5.13: PERCENTAGES OF CHILDREN REPORTED WITH ANTENATAL CARE, IMMUNIZATION, AND WEIGHT MEASUREMENTS BY DISTRICT

Use of Health Intervention	District of:				Region		Pct. Total	No. cases
	Kupang	TTS	TTU	Belu	Urban	Rural		
MOTHER EVER:								
Had ANC	54.1	52.4	67.3	58.3	79.0	47.2	57.0	2157
Had TT	38.1	19.5	39.6	30.7	57.0	26.0	30.1	1318
CHILD < 1 Yrs EVER:								
Immunized	35.9	22.6	42.9	20.7	39.9	27.9	29.4	305
DPT 1	33.1	19.4	35.9	17.2	36.8	23.9	25.5	265
DPT 2	16.7	11.4	13.6	13.8	24.8	12.1	13.8	143
DPT 3	8.2	7.3	7.6	5.2	15.0	6.0	7.1	74
Polio 1	32.4	19.9	35.9	17.2	36.8	29.3	25.5	265
Polio 2	15.7	11.4	13.6	9.1	24.8	10.6	12.4	129
Polio 3	8.2	6.7	7.6	5.6	13.5	6.1	7.0	73
Measles	4.6	4.7	4.4	2.6	10.5	3.2	4.1	43
BCG	34.5	19.7	35.9	17.2	39.1	24.1	26.0	270
BCG scar	26.0	18.4	37.4	14.8	41.2	20.7	23.3	221
CHILD $1- < 5$ Yrs EVER:								
Immunized	48.7	41.8	59.3	37.4	62.9	44.0	46.3	1844
DPT 1	38.7	30.1	42.3	22.3	53.4	30.5	33.3	1325
DPT 2	24.6	17.5	25.7	20.7	40.7	19.0	21.7	862
DPT 3	17.1	12.2	17.6	12.1	33.6	11.9	14.6	581
Polio 1	37.3	29.2	41.1	21.3	53.0	29.2	32.2	1280
Polio 2	23.6	16.7	25.1	15.7	40.0	17.2	20.0	797
Polio 3	16.5	11.9	17.2	12.2	33.0	11.6	14.2	567
Measles	18.0	12.9	15.2	12.4	31.8	12.2	14.6	581
BCG	42.3	31.7	43.4	25.5	54.6	33.0	35.6	1418
BCG scar	35.8	31.2	46.8	22.8	51.8	31.7	40.5	1301
UPGK:								
Weighed	74.0	63.0	76.1	63.0	73.9	66.9	67.7	3400
Given KMS	59.6	49.9	72.0	45.6	57.8	54.3	64.8	2741

has the highest percentage and followed by the districts of Belu (*58.3 percent*), Kupang (*54.1 percent*), and TTU (*52.4 percent*). Only about 30 percent of mothers of surviving children reported ever receiving TT immunization during the prenatal period.

Less than 26 percent of children under 1 received DPT or polio immunization for a first time, less than 14 percent for a second time, and about 7 percent for a third time. One–third of children ages 1-4 years received DPT and polio one time, 20 percent for a second time, and only 15 percent for a third time. The proportion of children under 1 immunized for BCG is 26 percent. About 36 percent of children ages $1-4$ were immunized for BCG. The proportion of children under 1 having a positive BCG scar is 23.1 percent. More than 40 percent of children ages $1-4$ years had a positive BCG scar. The lowest percentage of immunization is measles (*4.1 percent for under 1 and 14.6 percent for ages* $1-4$ *years*). This low percentage is due to the fact that the measles immunization was introduced into the national program less than 3 years ago.

Despite a significant differential between urban and rural areas in NTT, the immunization programs show a difference in levels of achievement between districts. Except measles, the TTU district shows the highest percentage of all children immunized, followed by the Kupang, TTS, and Belu districts.

The weighing program has been spreading through NTT province for more than 5 years. As a result, about two–thirds of children under 5 have ever been brought to a weighing program. Sixty–four percent of children have ever received KMS (*growth card*). Only 54 percent of children still had their growth cards at home, and many of these cards(*more than 25 percent*) contained either incorrect or incomplete

Table 5.14: PERCENTAGE OF CHILDREN ACCORDING TO THEIR BIRTH ATTENDANT, PLACE OF DELIVERIES, AND SOURCES OF TREATMENTS BY DISTRICT

Use of Health Intervention	District of: Kupang	TTS	TTU	Belu	Region: Urban	Rural	Pct. Total	No. cases
Birth Attend.								
Family	51.6	46.0	47.2	54.3	23.6	53.1	49.4	2480
TBA	34.2	43.1	39.3	29.5	34.0	37.7	37.3	1870
Nurse/Midwives	11.5	7.6	11.3	15.0	38.3	7.0	10.9	545
Doctor	1.5	.2	.4	.1	2.6	.3	.5	27
Other	1.2	3.1	1.8	1.1	1.6	2.0	1.9	97
Total:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	5019
Delivery At								
Home	92.4	96.0	93.1	88.6	74.4	95.7	93.0	4668
PHC	.5	1.0	.5	3.3	1.9	1.1	1.2	62
Clinic/Hosp.	6.8	1.4	2.9	3.5	15.1	1.9	3.5	176
Priv. Clinic	.3	1.5	3.4	4.3	8.5	1.2	2.1	107
Other	.0	.1	.1	.3	.2	.1	.1	6
Total:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	5019
Ill Past 2 weeks	15.7	24.1	18.5	21.5	20.3	13.9	21.2	1015
Treatment From								
Not treated	4.1	25.7	14.5	8.3	9.3	15.8	15.2	117
Drug store	7.0	.3	3.1	5.4	6.7	3.0	3.4	26
Health Cadre	3.5	8.0	1.5	2.4	.0	5.2	4.7	36
POSYANDU	11.7	8.7	7.6	3.6	2.7	8.6	8.1	62
PHC/Clinics	50.3	48.3	55.7	59.5	44.0	53.4	52.5	404
Hospital	6.4	.7	6.9	4.2	24.0	1.6	3.7	29
Priv. Pract.	3.5	4.0	8.4	10.1	9.3	5.2	5.6	43
Other	13.5	4.3	4.6	6.1	4.0	7.2	6.9	53
Total:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	770

information. About 20 percent of mothers did not remember what the last weight of their children was, whether it had improved, or was fair or poor. Assuming that the main purpose of the growth card is to remind the mother about her child's growth, the number may suggest something about the achievement of this goal in NTT. Again differentials between provinces as well as between urban and rural areas show a similar pattern to that of the immunization program.

Table 5.14 (*page 160*) shows data on the type of assistance for births that occurring in the five years before the survey. In NTT, 49.4 percent of births were attended by the family only, 37.3 percent by a traditional birth attendant, 10.9 percent either by trained nurse and midwives, and only 0.5 percent by a doctor. These figures do not vary widely by districts, but vary significantly between urban and rural areas. Births attended only by family in rural area are two times higher than in urban areas (*53.1 percent versus 23.6 percent*), while births attended by a nurse or midwifes in urban areas are 5 times higher than in rural areas (*38.3 versus 7.0 percent*). Most of births (*93 percent*) take place at home, so less than 1 in 10 deliveries occur at a hospital or health center.

The table also show the percentage of children reported ill within the last two weeks. Overall, about 1 in 5 children reported sick within the last two weeks. Although the district of Kupang shows the lowest percentage, the number still show that 15 percent of children in this study were reported sick within the last two weeks. This number is very close to the results from The National Household Health Survey in 1986, where about $16 - 18$ percent of under–5 children reported sick within the last four weeks (*Budiarso, et al., 1986*). The bottom panel of this table shows that about half of the sick children received treatment from a PHC. Eight percent of sick children received treatment from POSYANDU, 4.7 percent from health cadres, and about 9 percent form a hospital or private practice. Fifteen percent of them did not receive any treatment. It should be noted that most children showed with symptoms of: fever (*59 percent of sick children*), cough (*57 percent of sick children*), diarrhea (*43 percent of sick children*), vomiting (*20 percent of sick children*), skin rash (*6 percent of sick children*), tetanus/convulsion (*4.5 percent of sick children*), and other (*12 percent of children*).

Table 5.15: PERCENT OF MARRIED WOMEN AGE 15–49 IN TCS, 1988 AND NICPS, 1987 CURRENTLY USING FAMILY PLANNING METHODS BY DISTRICT AND RURALITY

FP used	District of: Kpg	TTS	TTU	Belu	Region Urb.	Rur.	Pct. Total	No. cases	NICPS 1988
Non user	67.3	62.7	52.7	71.5	52.1	64.51	63.0	3735	49.1
Injection	9.3	18.5	31.4	15.5	11.6	19.6	18.7	1105	10.7
Pill	6.3	4.9	5.8	6.3	9.8	5.2	5.7	338	16.0
IUD	9.2	3.5	5.6	3.5	12.5	4.5	5.4	332	15.5
Male Steril.	.7	4.1	.2	.0	.9	1.7	1.6	93	.2
Feml Steril.	2.9	1.4	1.1	.5	6.8	.8	1.5	91	3.5
Calender	1.2	1.6	1.6	.5	2.8	1.1	1.3	74	1.1
Condom	.9	.3	.1	.5	1.7	.2	.4	24	1.8
Other	2.2	3.0	2.1	1.9	1.5	2.5	2.4	141	3.4
Pct. user any method	32.7	37.3	47.3	28.5	47.9	35.5	37.0	5923	50.9

5.4.3 The Use of Family Planning Methods

Table 5.15 (*page 162*) shows that 37 percent of currently married women are using contraceptive methods in NTT. This means that 63 percent are not using any method which is about 14 percent lower than the NICPS, 1987 figure. Overall, 33.3 percent are using modern methods and 3.7 percent use traditional or natural family planning methods (*withdrawal, periodic abstinence, herbs, etc*). As with ever use, the injection (*18.7 percent*), pill (*5.7 percent*), IUD (*5.4 percent*) are the most commonly used methods, altogether accounting for over 80 percent of current users. Other contraceptive methods have a lower percentage of use, and these are male sterilization (*1.6 percent*), female sterilization (*1.5 percent*), condom (*0.4 percent*), and natural family planning (*1.3 percent*). It should be noted that despite the prevalence rate in this study being lower than national figure, the order according to the method used is also different. Clearly, injection is the most popular method in this study area, whereas the national figure shows the pill to be the most popular (*CBS, FPNCB, and DHS, 1989*).

Table 5.16: SOURCE OF FP SUPPLY OF ANY METHOD USED ACCORDING TO DISTRICT AND RURALITY

Source of FP Method	District of:				Region		Pct. Total	No. cases
	Kupang	TTS	TTU	Belu	Urban	Rural		
Clinic/Hosp	84.5	76.9	81.7	82.0	89.4	79.4	80.9	2201
POSYANDU	5.6	12.4	14.1	10.2	3.1	12.3	11.0	300
PLKB/TKBK	1.8	3.2	.5	2.2	.3	2.2	1.9	52
Private	2.1	1.2	.1	.9	3.1	.7	1.0	29
SAFARI	1.2	1.4	.9	.2	.3	1.1	1.0	27
Other	4.8	4.9	2.7	4.5	3.8	4.3	4.2	113
Total	611	852	809	450	387	2335	100.0	2772

In this study, contraceptive use is highest in District TTU and the lowest in District Belu. More than 47 percent of currently married women in TTU are using contraceptive methods, 43.6 percent of which are modern methods. This level of contraceptive use is similar to that found in national figures in the NICPS, 1987 data. Interestingly, the district with the highest overall prevalence rate has the highest proportion of injection use as well as the highest percentage of women who ever had ANC.

Table 5.16 (*page 163*) shows that PHCs, Hospital, clinics are the most important sources of contraceptive methods, supplying more than 80 percent of all users. On the other hand, community level services such as POSYANDU, SAFARI, PLKB and private sectors altogether only accounted for 14 percent of total sources.

Family planning use is higher among urban than rural women. Over 47 percent of currently married urban women are using a method, compared to 35 percent of rural women. In terms of sources of contraceptive supplies, hospitals, PHCs, clinics, and private sources are higher in urban than rural areas. On the other hand, POSYANDU is more frequently used in rural than urban areas

Chapter 6

DETERMINANTS OF CHILDHOOD MORTALITY

6.1 INTRODUCTION

The objective of the analysis in this chapter is to find a parsimonious model that explains the association between child survival interventions and mortality. This chapter begins with a presentation of level, trend, and determinants of mortality at the aggregate level. We calculated indirect estimates of infant and childhood mortality using information on the proportion of child deaths (*CD*) among children ever born (*CEB*) (*Brass, 1968; Sullivan, 1972; Trussell, 1975*). The United Nations Manual X (*1983*) explains this method in detail.

The indirect estimation method requires reliable information on birth history data and the duration of exposure to risk of child death. Here the duration of exposure is either women's ages or the duration of marriage since the first union. We asked respondents about the numbers of daughters and sons currently living in the same household and living outside their household, and how many had died. From these questions, we obtained the proportion of CD among CEB for each sex. Besides these data, respondents answered questions on the socioeconomic and proximate determinant variables. A level of mortality can be presented according to socioeconomic and proximate determinant variables.

We explored determinants of mortality by looking at the distribution of CD among CEB according to some of the mother's characteristics. Then data on CD and CEB at a given age or duration of marriage since the first union are converted to infant and child mortality. We present the levels of infant and child mortality according to mother's characteristics. Data on CD and CEB are also used to examine the trend–analysis of infant and childhood mortality by sex.

In the multivariable analysis, we used ordinary least squares (*OLS*) following the Trussell and Preston (*1982, 1984*) approach. This method uses a ratio between "observed proportion of CD" and "expected CD", given woman's duration of marriage as the dependent variable. From now on we called this dependent variable a mortality index (*MI*).

We did a survival analysis, as discussed in chapter 3, using the information on CEB born within the past 5 years. This analysis involves similar a conceptual framework as in the OLS for MI. But, some explanatory variables used different of indicators measure because better information were available on individual children.

6.2 PROPORTION CD AMONG CEB

The proportion of CEB who have died is an indicator of childhood mortality. The reasoning is that the proportion of children who have died represents the probability of dying between the time of birth and some exact age in childhood. Using Brass type analysis, one can convert the proportion of CD into a life table probability of dying. Here we multiply the proportion of CD with an adjustment factor that depends on the fertility schedule of the population.

Table 6.1 (*pages 167 – 168*) shows the numbers of CEB and CD, and the proportion of CD to CEB according to various explanatory variables discussed in Chapter 4. Some variables associated with child survival interventions show lower proportions of CD among CEB, such as household with modern drugs, women ever had ANC, and use of contraception. But, the availability of growth card within the household suggests no association with the proportion of CD among CEB. It should be noted that the growth card acts as a gross measure of preventive illness control, because this proportion disregards women's age and parity.

The proportion of CD among CEB decreases with an increasing level of women's education. Women's categories on the place of work outside home, member of a social organization, ever of heard immunization, and non-Catholic religion show a lower proportion of CD among CEB compared to their reference category.

The proportion of CD among CEB decreases with increasing quality of latrine facility, higher level of husband's education, higher family income, and availability of modern facilities at home. Availability of electricity, source of income from nonagricultural setting, husband's *pegawai negeri or* ABRI all show a lower proportion of CD among CEB. Rural has higher proportion CD among CEB than urban, and this proportion also varies between districts.

Table 6.1: PROPORTION OF CHILDREN EVER BORN (CEB) AND DEAD (CD) BY VARIOUS SOCIOECONOMIC AND DEMOGRAPHIC VARIABLES OF WOMEN AGED 15-49 YEARS IN TIMOR, INDONESIA

VARIABLES	No. of WOMEN	CEB	CD	PROPORTION
WOMEN'S AGE				
15–19	71	74	10	0.135
20–24	717	1243	89	0.072
25–29	1353	3507	325	0.093
30–34	1240	4593	559	0.122
35–39	1098	4845	638	0.132
40–44	789	4200	667	0.159
44–49	706	3978	690	0.174
DURATION OF MARRIAGE				
00–04	968	1347	93	0.069
05–09	1460	3789	326	0.086
10–14	1216	4727	529	0.123
15–19	996	4754	625	0.132
20–24	731	4063	679	0.167
25–29	459	2946	531	0.180
30+	135	807	145	0.180
PROXIMATE DETERMINANTS				
PARITY OF WOMEN				
1	732	732	28	0.038
2–3	1896	4739	337	0.071
4–6	1806	8725	1063	0.122
7+	996	8244	1550	0.188
HOUSEHOLD KEPT KMS				
No	4389	16651	2267	0.136
Yes	1585	5789	711	0.123
MODERN DRUGS AVAILABLE				
No	5236	19571	2653	0.136
Yes	737	2861	324	0.113
EVER HAD ANC				
No	2504	9047	1343	0.148
Yes 1–3 times	848	3461	476	0.138
Yes 4 times/more	1622	9932	1159	0.117
CONTRACEPTIVE USE				
Never used	3111	9890	1449	0.147
Ever used	2863	12550	1529	0.122
MAIN FLOOR MATERIALS				
Non-concrete	4731	17342	2388	0.138
Concrete	1242	5090	589	0.116
MAIN WALL MATERIALS				
Non-concrete	4667	16879	2264	0.134
Concrete	1306	5553	713	0.128
DRINKING WATER				
Non pipe	3598	13419	1769	0.132
Using pipe/well	2375	9013	1208	0.134
WATER FOR WASHING				
Non pipe	3647	13629	1810	0.133
Using pipe	2326	8803	1167	0.133
LATRINE FACILITIES				
River/garden	773	2900	461	0.159
No Septic Tank	4747	17673	2359	0.134
With Septic Tank	453	1859	157	0.084
AVAILABILITY OF SOAP				
No	3069	11533	1664	0.144
Yes	2902	10889	1311	0.120
CROWDING INDEX				
Not crowded	1539	4096	589	0.144
Crowded	4435	18344	2389	0.130
(*Continued on next page)*				

Table 6.1: CONTINUED

VARIABLES	No. of WOMEN	CEB	CD	PROPORTION
EDUCATION, OCCUPATION, RELIGION, HEALTH KNOWLEDGE				
WOMEN'S EDUCATION				
None	1902	7854	1239	0.158
Some Primary	1103	4301	560	0.130
Primary Completed	2270	7977	1017	0.128
Secondary and above	669	2308	162	0.072
PLACE OF WORK				
At Home	4780	17799	2364	0.133
Outside home	1194	4661	614	0.132
SOCIAL ORGANIZATION				
Non-member	4208	15587	2174	0.140
Member	1766	6853	804	0.117
HEARD IMMUNIZATION				
Never heard	3067	11572	1712	0.148
Ever heard	2907	10868	1266	0.117
WOMEN'S RELIGION				
Roman Catholic	2767	10359	1487	0.144
Other	3207	12081	1491	0.123
HOUSEHOLD'S SOCIO-ECONOMIC LEVELS				
HUSBAND'S EDUCATION				
None	1782	6934	1007	0.145
Some Primary	1102	4230	612	0.145
Primary Completed	1975	7100	954	0.134
Secondary and above	1115	4176	405	0.097
HUSBAND'S OCCUPATION				
None/Self employe	3988	14644	2007	0.137
Private with employer	1195	4689	707	0.151
Civil Servant/Army	783	3104	264	0.085
MODERN AMENITIES				
Not Available	3285	11775	1692	0.144
Available	2688	10657	1285	0.121
ELECTRICITY				
Not Available	4961	18338	2587	0.141
Available	1012	4094	390	0.095
TOTAL CASH EXPENDITURE				
Below median pop.	2720	9036	1278	0.141
Above median pop.	3253	13396	1699	0.127
MAIN SOURCE OF INCOME				
Agriculture	4913	18289	2585	0.141
Non-Agriculture	1052	4105	387	0.094
TYPE,PLACE, AND REGION OF RESIDENCE				
PLACE OF RESIDENCE				
Rural	5277	19689	2739	0.139
Urban	697	2751	239	0.087
REGION OF RESIDENCE				
District Kupang	1492	5488	722	0.132
District TTS	1955	7483	854	0.114
District TTU	1400	5086	742	0.146
District Belu	1127	4383	660	0.151

There are a few variables that indicate inconsistent with our hypotheses. These variables are: sources water for drinking, water for washing, and a crowding index. These relationships will be re–examined further in the next section. Nevertheless Table 6.1 shows a strong indication about the differential of mortality according to proximate determinants and socioeconomic status.

6.3 LEVELS AND TRENDS OF INFANT AND CHILD MORTALITY

The United Nations (*1983*) method for estimating child mortality from CEB and CD requires the prior selection of an appropriate pattern of child mortality from families of life tables, such as the Coale–Demeny's life table (*1966*). To maintain comparability of the numbers with previous reports (*CBS, 1986*), we used the West model of family life table (*Coale and Demeny, 1966*).

The software used in this study can produce mortality estimates according to all four models from the Coale–Demeny life table. We converted each proportion of death into a probability of dying by an exact age of childhood. The reference times are also estimated for probabilities of dying from age 0 up to age 1 $({}_1q_0)$, and age 1 up to age 5 $({}_4q_1)$, using the United Nation's method (*1983*).

To simplify presentation and comparison, we converted each probability of dying corresponding to the standardized form, which is the probability of dying by exact age 1 or 5, and probability of dying from age 1 up to age 5 years. The standardized form here is the probability of dying according to the West model life table, which is estimated from q_x observed values using an interpolation approach.

When the probability of dying was calculated based on the duration of marriage, we present the probability dying from age 1 to 5 years, instead of from births to 5 years. To obtain a single mortality index we averaged values of the standardized form corresponding to women age group $20 - 34$ years or duration of marriage less than 15 years.

Figure 6.1(page 171) the proportion of children ever born that were dead is converted to life table probabilities that a child will die by age 1, or q_1, according to sex and residences. We often refer to the value of q_1 as an infant mortality rate (*IMR*), which has a direct interpretation for policy makers. The number corresponds to the West child mortality model at level 17.2, or a life expectancy of 58.9 years.

As can be seen from Figure 6.1 the IMR estimated in Timor is 76 per 1,000 births, which covered a period between December 1982 to January 1987. As expected, the IMR for females is lower compared to the IMR for male (*66 versus 86 per 1,000 births*). All four districts show similar mortality differentials between sex.

The levels of mortality up to age 5 or q_5 has similar patterns to those the IMR. In Figure 6.2 (*page 171*), the probability of dying from birth to age 5 $({}_5q_0)$ is 106 per 1,000 births; that is an average number from the period of December 1982 to January 1987. Female had lower probability of dying up to age 5 years than males ($q_5 = 93$ *versus* 118).

From the information of CEB and CD, we can estimate trends of IMR and childhood mortality (*United Nations, 1983*). Figure 6.3 (page 173) shows that the IMR declined slowly from 1974 to 1982, and gained speed in the next 5 years. An estimate of the IMR for early 1977 is about 100 per 1,000 births, and by early 1987 the IMR is about 67. This suggests that the decline of IMR is about 3.3 units per year. Figure 6.4 (page 173) shows that $({}_4q_1)$ also declined slowly from 1974

Figure 6.1: LEVELS OF INFANT MORTALITY BY DISTRICT

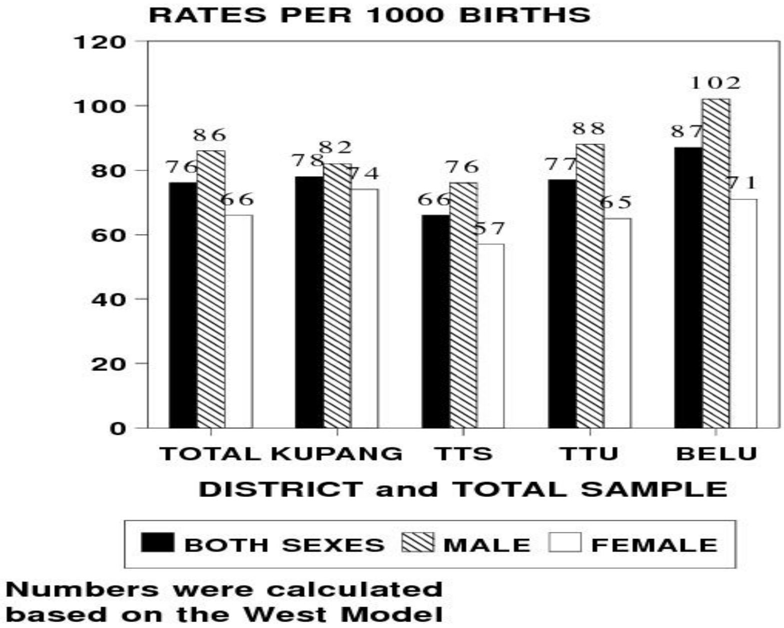
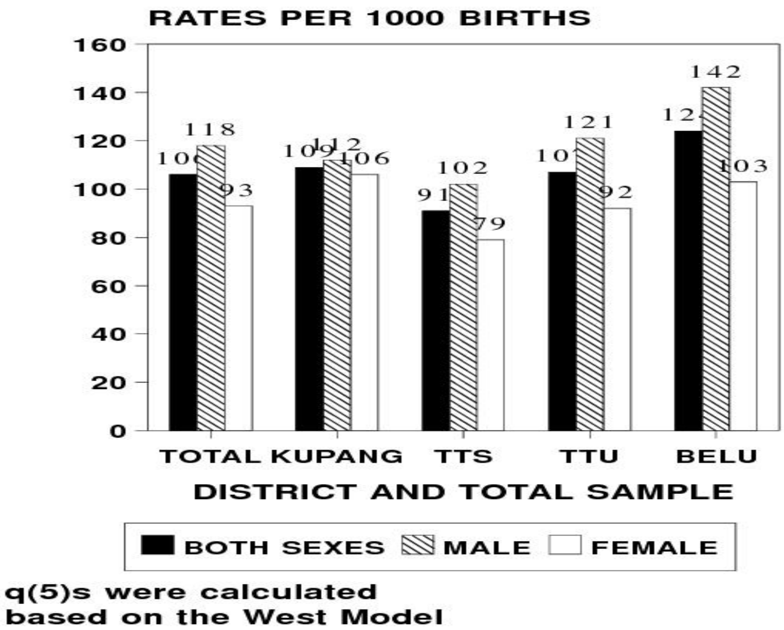


Figure 6.2: LEVELS OF MORTALITY UP TO AGE 5 YEARS BY DISTRICT



to 1982, and gained speed in the next 5 years.

6.4 INDIRECT ESTIMATES OF INFANT AND CHILD MORTALITY

6.4.1 Proximate Determinants of Mortality

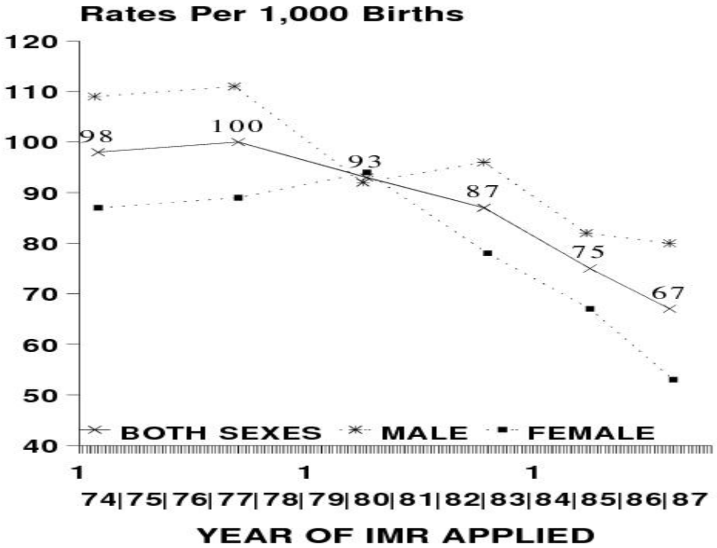
Personal Preventive and Curative Controls

Table 6.2 (*pages 174 – 175*) shows that contraceptive users have lower mortality levels ${}_1q_0$ and ${}_4q_1$ than nonusers. Women "ever had ANC 1 to 3 times" have lower mortality than "never had ANC"; while "ANC 4 times or more" have lower mortality levels than "ANC $1-3$ times". There is no strong evidence on the association between the availability of modern drugs and have a growth card at home with mortality levels. Households with and without modern drugs differ only less than 5 units. Similarly, categories on the growth card variable show no differences regarding infant and child mortality levels. Thus results from indirect estimates, only the history of contraceptive use and ever had ANC show strong associations with mortality rate.

Environmental Factors

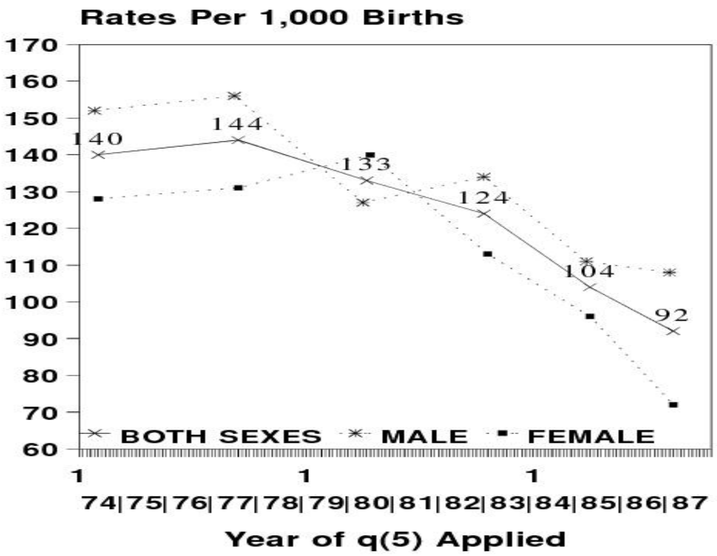
A latrine facility variable shows a strong association with the level of infant and child mortality (*Table 6.2*). The IMR of women with a septic tank latrine is about one–half that for women who do not have a latrine facility (*43 versus 86 per 1,000 births*).

Figure 6.3: TRENDS OF INFANT MORTALITY BY DISTRICT



IMRs were calculated following
UN-MANUAL X West Model

Figure 6.4: TRENDS OF MORTALITY UP TO AGE 5 YEARS, TIMOR, 1988



q(5)s were calculated following
UN-MANUAL X West Model

Table 6.2: INDIRECT ESTIMATES OF CHILDHOOD MORTALITY BY VARIOUS SOCIOECONOMIC AND DEMOGRAPHIC VARIABLES OF WOMEN AGED 15-49 YEARS IN TIMOR, INDONESIA

VARIABLES	Estimates of mortality ×1000	
	Age 0–1	Age 1–4
PROXIMATE DETERMINANTS		
HOUSEHOLD KEPT KMS		
No	73	31
Yes	72	30
MODERN DRUGS AVAILABLE		
No	73	31
Yes	67	28
EVER HAD ANC		
No	81	36
Yes 1–3 times	70	29
Yes 4 times/more	67	27
CONTRACEPTIVE USE		
Never used	78	35
Ever used	68	28
MAIN FLOOR MATERIALS		
Non-concrete	74	31
Concrete	65	26
MAIN WALL MATERIALS		
Non–concrete	74	32
Concrete	64	25
DRINKING WATER		
Non pipe	74	32
Using pipe/well	69	29
WATER FOR WASHING		
Non pipe	74	31
Using pipe	69	29
LATRINE FACILITIES		
River/garden	86	40
Pit latrine	72	31
With Septic Tank	43	13
AVAILABILITY OF SOAP		
No	76	33
Yes	69	28
CROWDING INDEX		
Not crowded	93	45
Crowded	67	27
(Continued on next page)		

Table 6.2: CONTINUED

VARIABLES	Estimates of mortality ×1000	
	Age 0–1	Age 1–4
WOMEN'S CHARACTERISTICS		
WOMEN'S EDUCATION		
None	89	41
Some Primary	78	34
Primary Completed	77	33
Secondary and above	44	14
PLACE OF WORK		
At Home	75	32
Outside home	62	25
SOCIAL ORGANIZATION		
Non-member	76	33
Member	65	25
HEARD IMMUNIZATION		
Never heard	83	38
Ever heard	63	25
WOMAN'S RELIGION		
Roman Catholic	76	37
Other	69	28
HUSBAND'S EDUCATION		
None	76	34
Some Primary	78	35
Primary Completed	77	33
Secondary and above	61	24
SOCIAL-ECONOMIC VARIABLES		
HUSBAND'S OCCUPATION		
None/self–employed	77	33
Private with employer	76	33
Civil Servant/Army	46	10
MODERN AMENITIES		
Not Available	80	36
Available	63	25
ELECTRICITY		
Not Available	75	33
Available	57	22
TOTAL CASH EXPENDITURE		
Below median pop.	80	35
Above median pop.	66	27
MAIN SOURCE OF INCOME		
Agriculture	77	34
Non-Agriculture	55	19
TYPE AND REGION OF RESIDENCE		
PLACE OF RESIDENCE		
Rural	79	35
Urban	50	16
REGION OF RESIDENCE		
District Kupang	78	35
District TTS	66	27
District TTU	77	34
District Belu	87	40

The mortality rates also suggest that the environmental threat is stronger to child than to infant. The reason may be that most disease associated with the availability of a latrine would be gastrointestinal ones frequently found after age 1 year. As we can see in Table 6.2, the child mortality for ages 1 to 5 years among women with a flush latrine is below one–third that among women without a latrine facility. Even if we compare no facility with group of women with a pit latrine (*without a septic tank*), the difference remains (*72 versus 86 per 1,000 births*).

It should be noted that the availability of a flush latrine may be strongly associated with the better of socioeconomic level of the household. It is difficult therefore to conclude from this analysis that latrine is definitely play a significant role as a preventive measure associated with the environmental contamination.

Other environmental factors, such as floor or wall materials, have the expected magnitude of association with mortality levels. But the association is very weak. Mothers living in a house having walls made of concrete materials show lower mortality levels compared to other women. The finding was similar for women living in houses with, as opposed to without concrete floors.

One indicator of maintaining personal hygiene is the availability of soap within the household. Our finding from aggregate levels also shows that both the IMR and ${}_4q_1$ can be associated with the availability of soap within the household. The theoretical role of this variable seems obvious, but the empirical findings at this stage may simply be due to a strong association between woman's economic status and the availability of soap within the household.

The sources of water supply for drinking and washing do not show a significant association with mortality levels. Without data on the quantity of water supplies, the quality of source of water may not be adequate information to explain the importance of water sources, especially in areas where water sources are affected by season. This may be the case in this study area.

We found an unexpected association between "a crowding index" and the mortality rate. Women from less crowded households (*above median of crowding index*) have a higher mortality rate than women from crowded households. Apart from possible measurement problems, there may be a spurious association between crowding index and mortality level. One possible explanation is the tendency of a higher prevalence of household crowding in urban than in ruaral areas, whereas urban areas are more likely to have lower mortality than rural areas.

6.4.2 Woman's Characteristics

Infant or child mortality seems inversely related to mother's educational attainment. Children of women with less education have a higher of mortality risk than children of women with more education (*Table 6.2*). However, the mortality differences between women with no education and those with some primary education are very small. If these two groups are combined and compared with those who completed primary school, or those who finished secondary school or higher, the difference becomes significant (*See Figure 6.5 (page 179) and Figure 6.6 (page 179)*).

Table 6.2 shows that women whoever heard the word "immunization" have lower mortality levels than women who have "never heard of immunization". These differentials may not merely operate through child immunization, but may also serve as a proxy for general health knowledge of these women.

Both place of employment and membership in a social organization are associated with lower mortality indices. A woman working outside the home is more likely to have contacts with other women, so exchanges of health knowledge may likely occur. Economic gains may play an important role in explaining mortality differentials between women working inside and outside the home. Similarly, membership in a social organization may be associated with low mortality levels, because of the diffusion of health knowledge and services through social organization. This diffusion is mainly through *PKK* and *Darma Wanita* organizations.

A woman's religion may affect her behavior toward the acceptance of modern technologies, such as a family planning program. Considering the fact that many child survival programs are integrated with a family planning program, there may be some differential mortality associated with religion affiliation. Table 6.2 shows that Catholic women have higher child mortality experiences than non-Catholic women.

6.4.3 Households and Socioeconomic status

Higher income and wealth can be associated with lower infant and child mortality. Variables on the availability of electricity, modern amenities, higher total cash expenditures, and source of income from a nonagriculture setting can be associated with lower mortality levels. If husband's occupation is a civil servant (*pegawai negeri*) or military staff (*ABRI*), the mortality levels are much lower compared to other groups. This may be because of being *pegawai negeri* or *ABRI*, husband has somewhat free access to health services and is more knowl-

Figure 6.5: LEVELS OF INFANT MORTALITY BY MOTHER'S EDUCATION

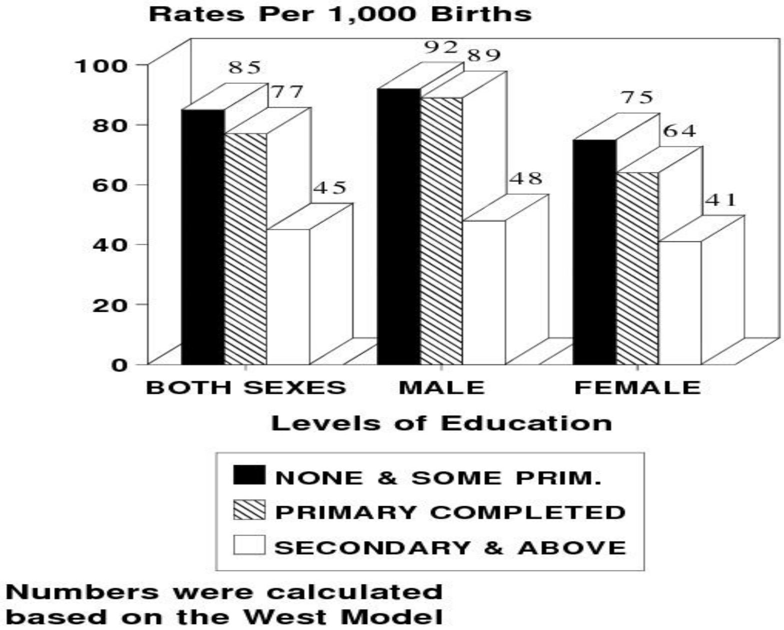
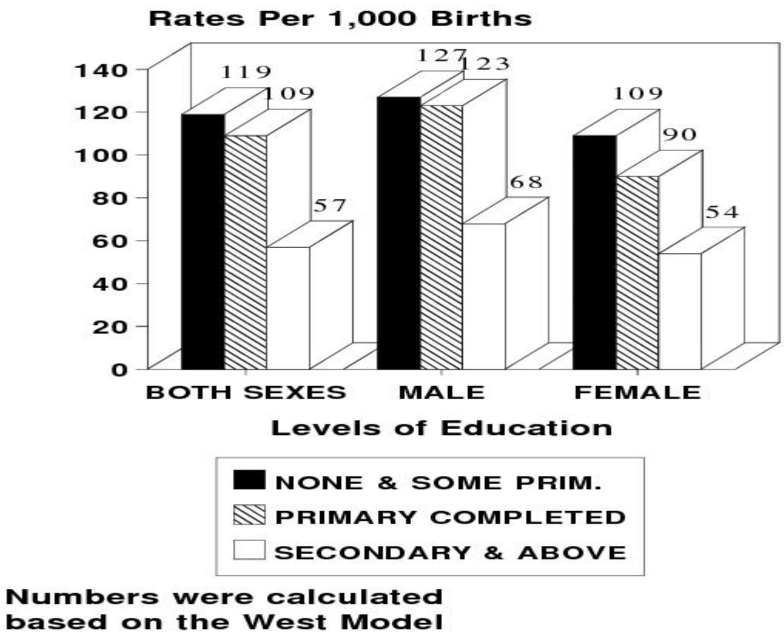


Figure 6.6: LEVELS OF CHILD MORTALITY UP TO AGE 5 YEARS BY MOTHER'S EDUCATION



edgeable about government health and family planning programs.

6.4.4 Type of Place and Regions of Residence

Figure 6.7 (*page 181*) shows a higher level of IMR in rural areas compared to urban areas. Lower mortality in urban areas may be due to a greater availability of health facilities and services, besides the other obvious advantages of residing in an urban area, such as educational facilities, housing conditions, etc. Figure 6.8 (*page 181*) shows ${}_4q_0$ according urban–rural regions and districts. Data also show that the mortality level is lower in urban areas than in rural areas.

Figure 6.1 (*page 171*) also shows differentials of mortality according to regions (*district*). The district of Belu has the highest IMR, and TTS has the lowest. Figure 6.2 (*page 171*) also shows that the District of Belu has the highest values of q(*5*), while TTS has the lowest mortality compared to other two districts. This differential between districts is consistent with the previous estimates from the SUPAS data, 1985 (*Kantor Statistik Provinsi NTT, 1986*).

6.5 REGRESSION ANALYSIS USING CD AND CEB

To examine the simultaneous effects of socioeconomic factors and proximate determinants, a multiple regression analysis was used. In this approach, we are using the information on CD, CEB, and duration of marriage as the basis of creation of mortality indices (*MI as a dependent variable*). The dependent variable is the ratio of observed death to expected death for each woman with a birth, at her marital duration (*Trussell and Preston, 1982, 1984*).

The unit observation of MI is the woman, but in the regression

Figure 6.7: LEVELS OF INFANT MORTALITY BY RESIDENCE

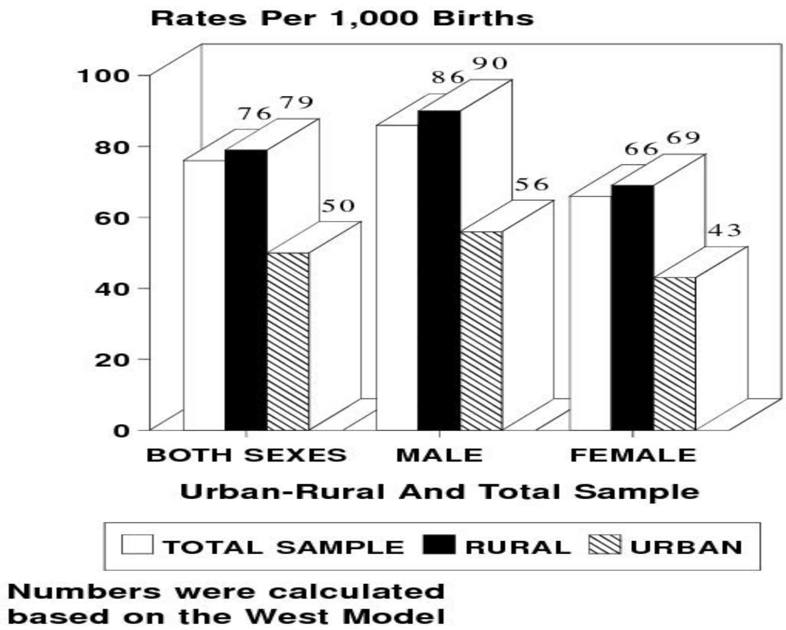
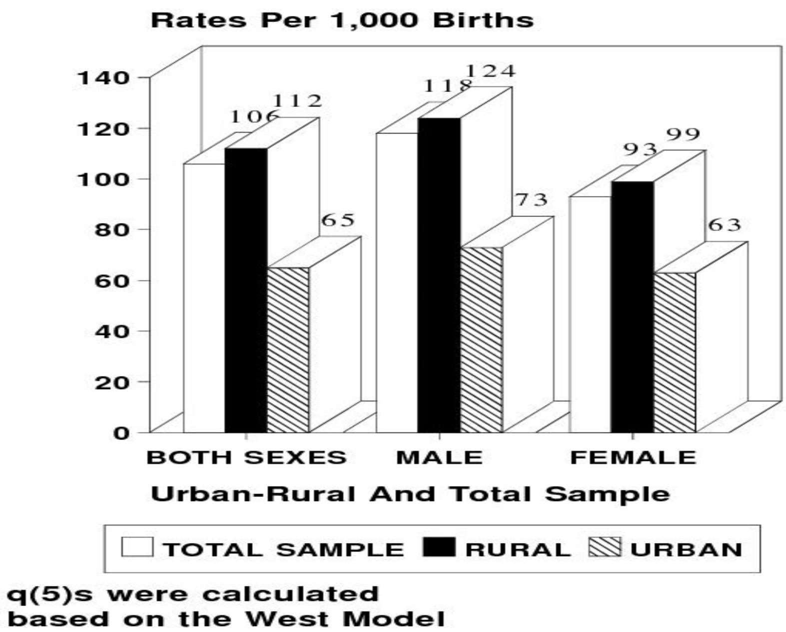


Figure 6.8: LEVELS OF CHILD MORTALITY UP TO AGE 5 YEARS BY RESIDENCE



analysis each observation is weighted by the woman's number of births, to convert the unit analysis from the mother to the child. Our analysis should take care of the facts that: 1) the women with longer duration of marriage are more likely to have older children, 2) the longer the duration of marriage the longer the period of exposure to risk of dying, and 3) the mortality rate has been changing over time.

6.5.1 Dependent Variable and Model Assumption

Although the concept of mortality indices (*MI*) here is straightforward, the computation of expected death requires further explanation. The expected number of deaths is calculated as:

$$E_i = CEB_{i(\delta)}.PD^s_{(\delta)}, \tag{6.1}$$

where CEB_i is the number of children ever born to women in the ith covariate group with marital duration δ, and where $PD^s_{(\delta)}$ is the standard expected proportion dead to women in marital duration δ. The value of $CEB_{i(\delta)}$ in equation 6.1 can be obtained directly from the respondent's answer.

To obtain $PD^s_{(\delta)}$, we invert the process whereby proportions of dead children by duration of marriage are converted into estimates of childhood mortality by this formula:

$$q^s_{(x)} = PD^s_{(\delta)} \times K^s_{(\delta)}, \tag{6.2}$$

where $K^s_{(\delta)}$ is a multiplying factor that depends on the average parities of women married $0-4$, $5-9$, and $10-14$ years and $q^s_{(x)}$ is an appropriate standard schedule of probability of dying by exact age x. Thus by inverting the formula 6.2 we obtain the expected proportion of dead

Table 6.3: STANDARD q_x VALUES FOR THE SOUTH AND WEST FAMILIES OF MODEL LIFE TABLES IN THE COALE-DEMENY SYSTEM LEVEL 17 FOR BOTH SEXES COMBINED†

Marital Duration Group	Age Group‡ of Women	Corresponding age of child death	q_x West Model
–	15–19	1	0.07863
00–04	20–24	2	0.09416
05–09	25–29	3	0.10138
10–14	30–34	5	0.11002
15–19	35–39	10	0.12015
20–24	40–44	15	0.12778
25–29	45–49	20	0.13924
30–34	–	25	0.15475

Note: † *These q_x values are converted from ℓ_x values listed in table No. 238 U.N. Manual X.*

‡ *Age Group: the proportion died in the duration or age group corresponds roughly to q_x*

among child ever born as follows:

$$PD^s_{(\delta)} = q^s_{(x)}/K^s_{(\delta)}. \tag{6.3}$$

Table 6.3 (*page 183*) presents values of $q^s_{(x)}$ taken from the Coale–Demeny model life tables (*West model at level 17*). $K^s_{(\delta)}$ is estimated from regression equations involving average parities $P_{(\delta)}$ in duration groups $\delta = 1, 2$ and 3, which is taken from the United Nations MANUAL X (*1983*). The regression equations is:

$$K^s_{\delta} = a_\delta + b_\delta \times P_1/P_2 + c_\delta \times P_2/P_3, \tag{6.4}$$

where $P_{(1)}$ is average parities of women with marital duration $0-4$ years ($\delta = 1$), $P_{(2)}$ marital duration $5-9$ years ($\delta = 2$), and $P_{(3)}$ marital duration $10-14$ years ($\delta = 3$). Here, the parity ratio for the entire population is employed; the values of P_1, P_2, and P_3 in our data are 1.392, 2.595, and 3.887 respectively. Table 6.4 (*page 184*) presents regression coefficients for $a_{(\delta)}$, $b_{(\delta)}$, and $c_{(\delta)}$. After the values of E_i are obtained for

Table 6.4: REGRESSION COEFFICIENTS TO BE USED IN ADJUSTMENT FACTORS $K(\delta)$ ON THE DATA CLASSIFIED BY MARITAL DURATION ON THE WEST MODEL LIFE TABLE

Marital Duration	δ	q_δ/D_δ	a_δ	b_δ	b_δ
00–04	1	q_2/D_1	1.2584	–0.4683	0.1080
05–09	2	q_3/D_2	1.1841	–0.3006	–0.0892
10–14	3	q_5/D_3	1.2446	0.0131	–0.3555
15–19	4	q_{10}/D_4	1.3353	0.1157	–0.5245
20–24	5	q_{15}/D_5	1.3875	–0.0193	–0.5472
25–29	6	q_{20}/D_6	1.4227	–0.1954	–0.5127
30–34	7	q_{25}/D_7	1.4432	–0.1977	–0.5339

Regression equation:
$K_\delta = a_\delta + b_\delta \times P_1/P_2 + c_\delta \times P_2/P_3$
The values of $P_1, P_2,$ and P_3 are given in the text.

each woman, the mortality indices (***MI***) can be calculated as follows:

$$MI = CD_i/E_i, \tag{6.5}$$

where CD_i is the number of children dead among children ever born, given a woman with duration of marriage δ and ith vector covarite. This covariate can be a discrete or continuous. Finally, each woman with n CEB will contribute n observations (*unit analysis is child*) in regression analysis.

The expected values of MI should average close to unity, if all women experience a child mortality and the observed number of dead is equal to the expected. The interpretation for each woman is that a value above unity indicates a higher number of dead than expected, whereas a value below unity implies fewer numbers of death than expected. But, a mother with child death is a rare event, so that the observed mean of MI in the population would not be close to unity. For example, in our sample the mean value of MI is equal to 0.6980, but the median is equal to zero and range values are moving from 0 to 11.4624. Therefore it is difficult to interpret mean values, since some observations could be considered as a censored observation.

Each woman will contribute the same values to the dependent variable created, as her number of CEB. For example, if woman has three CEB and her value of MI is equal 1.020, then she will contribute 3 observations in the analysis with the same values of covariates and the dependent variable (*MI=1.020*).

Since we are using OLS, there are many assumptions violated by the Trussell and Preston approach (*1982, 1984*). First, the distribution of MI is far from normal, since most women will have no deceased children, and therefore many observations will have zero values.[1] Second, the MI has no independent observation, for two reasons: 1) the values are replicated from each woman as much as the number of CEB, and 2) the expected proportion of children dead is calculated on the assumption that distribution of children by exposure to risk does not vary systematically with the covariates used within marital duration. Third, the variance of MI is systematically dependent on the number of CEB. Clearly, the OLS is not an ideal method. However, Trussell and Preston (*1982, 1984*) also claimed that if the purpose of analysis is to identify the magnitude of relationships (*the sign of parameter estimate*), the OLS method would seem to be an appropriate approach. Since this is the case for our analysis here, we will use OLS. In the first step, a simple regression will be performed and then it is followed by multiple regression. Model selection and interpretation follow guidelines in Chapter 3.

[1]One may consider that the actual distribution of outcome is following a censored distribution. For this reason, Trussell and Preston (*1982, 1984*) also suggested to use censored regression or TOBIT model (*Tobin, 1958*).

6.5.2 A Simple Regression

Before we proceed with the multivariable analysis, we examined the consistency of MI as the dependent variable and compare the result to the previous indirect estimate. Table 6.5 (*pages 188 – 189*) shows the regression coefficients (*slope and intercept*), standard errors of each coefficient, and the P values of hypothesis testing that coefficients are not equal to zero (*t-statistics*). The explanatory variables used were mostly categorized as in the previous analysis, and the deleted or reference category was the category expected to show the highest mortality indices (*MI*). For example, we excluded categories of had no growth card and never had ANC from the list because we used these categories as references. Here the reference category is expected to show the highest MI value.

Table 6.5 shows that most coefficients have a negative sign, except two variables: growth card and crowding index. The negative coefficient means that women with this negative slope have a lower predicted MI than women in the group category deleted. For example, we consider noncontraceptive user as a reference category, so we expect that the contraceptive user category has a lower risk of child death than the noncontraceptive category. Thus the coefficient of the contraceptive user category should be significantly lower than zero (*a negative sign*).

Some coefficients of explanatory variables are not different from zero (*statistically not significant with* $P > 0.05$). In general, however, the findings are very close to the aggregate analysis using the indirect estimation method presented in Table 6.2 (*page 174*). Even with results that are inconsistent with a theoretical framework, data show similar results between a simple regression and the indirect estimation. For example, a crowding index variable shows inconsistent results with the theoretical framework both in regression and indirect estimation techniques.

The simple OLS suggests that variables “ever had ANC” and “ever used contraceptive method” are significantly associated with lower MI. For example, MI of “women ever had ANC 4 times or more” are .196 lower than “women never had ANC” (*reference category*). Similarly, the use of contraceptive method can be associated with a lower MI.

So far, analysis has not taken into account other variables in the model. Further multivariable analysis is required to justify whether these health intervention variables are really determining infant or child mortality. There are many socioeconomic characteristics that may affect such an association. Table 6.5 shows that many other variables (*knowledge of immunization, religion, education, occupation, income and residence*) are also associated with the MI. Thus it is likely that these variables affect the association between MI and child survival interventions (*size and sign of parameter estimates*). Nevertheless, the data suggest that there are many probable associations between child survival interventions and the MI.

Although an indirect estimation analysis shows a similar result as the OLS analysis, the use of OLS for MI will have more advantages compared to an indirect method. There are two reasons for this. First, the OLS using MI can take many explanatory variables into account simultaneously. Second, the use of MI can accommodate a continuous covariate, whereas the indirect method requires a categorical form as an explanatory variable.

Table 6.5: SIMPLE REGRESSION COEFFICIENTS ON THE RATIO OF OBSERVED TO EXPECTED DEATH WITH VARIOUS FACTORS FOR WOMEN MARRIED < 15 YEARS IN TIMOR, INDONESIA

VARIABLES	Coefficients	SE-Coeff.	P-Values
HOUSEHOLD KEPT KMS			
Yes	.018	.034	.609†
MODERN DRUGS AVAILABLE			
Yes	–.011	.047	.821 †
EVER HAD ANC			
Yes 1-3 times	–.149	.051	.003
Yes 4 times/more	–.196	.037	.000
CONTRACEPTIVE USE			
Ever used	–.163	.033	.000
MAIN FLOOR MATERIALS			
Concrete	–.229	.041	.000
MAIN WALL MATERIALS			
Concrete	–.175	.041	.000
DRINKING WATER			
Using pipe/well	–.062	.033	.063†
WATER FOR WASHING			
Using pipe	–.074	.034	.029
LATRINE FACILITIES			
Pit latrine	–.257	.047	.000
With Septic Tank	–.733	.077	.000
AVAILABILITY OF SOAP			
Yes	–.125	.033	.000
CROWDING INDEX			
Square meter/person	–.016	.003	.000
WOMEN'S EDUCATION			
Some Primary	–.119	.050	.019
Primary Completed	–.146	.042	.000
Secondary and above	–.607	.056	.000
PLACE OF WORK			
Outside home	–.068	.042	.104†
SOCIAL ORGANIZATION			
Member organization	–.197	.036	.000
HEARD IMMUNIZATION			
Ever heard	–.261	.033	.000
WOMAN'S RELIGION			
Non-Catholic	–.140	.033	.000
(*Continued on next page)*			

Table 6.5: CONTINUED

VARIABLES	Coefficients	SE-Coeff.	P-Values
HUSBAND'S EDUCATION			
Some Primary	–.109	.052	.040
Primary Completed	–.088	.044	.050
Secondary and above	–.303	.049	.000
HUSBAND'S OCCUPATION			
Private with employer	–.049	.073	.508 †
Civil Servant/Army	–.482	.083	.000
MODERN AMENITIES			
Available	–.214	.033	.000
ELECTRICITY			
Available	–.366	.043	.000
TOTAL CASH EXPENDITURE			
In thousand Rupiah	–.002	.000	.000
MAIN SOURCE OF INCOME			
Non-Agriculture	–.366	.042	.000
AREAS OF RESIDENCE			
Urban	–.387	.049	.000
PLACE OF RESIDENCE			
District Kupang	–.212	.049	.000
District TTS	–.432	.046	.000
District TTU	–.272	.051	.000

Note: The coefficient of each categorial factor represents contrast with categories deleted. † P-VALUES $\geq .05$

6.5.3 Multiple Regression

Following the conceptual framework discussed in chapter 3, we present the results of regressing "the observed over expected dead" (*MI*) on a set of child survival interventions. Table 6.6 (*page 191*) shows the direct effects of proxies of growth monitoring (*UPGK*), ORT, ANC, and the use of modern contraceptive method to MI, which have been adjusted for women's parity and marital duration. Here ORT is a more specific measure of child survival intervention than is the availability of modern drugs.

Besides women's parity and marital duration are biologically importance as determinants of a child mortality, a longer marital duration is likely to increase parity and the probability of a woman's exposure to higher risks of child death. Although MI has been created such that MI is adjusted by women's parity and marital duration, a potential bias arises when parity and marital duration variables are excluded from the model.

At least two problems can be associated with the exclusion of marital duration and parity from the model. First, our data suggest that child mortality has been declining steadily while health interventions and socioeconomic variables have been rising. Women with a longer marital duration will have above average values of MI, because their children will have been exposed to higher mortality risks in the past, whereas women with a shorter marital duration will have below average values of MI. For example, female education level has been increasing in the past decade. So the longer marital duration groups will have lower education, and the shorter marital duration groups will have higher education. Second, without contraceptive use, longer marital duration may imply a higher parity, and higher parity

Table 6.6: ESTIMATED COEFFICIENTS OF MULTIPLE REGRESSIONS OF VARIABLE INTERVENTIONS ON MI AND THEIR P VALUES BASED ON DURATION OF MARRIAGE < 15 YEARS

VARIABLES	Eq.1	Eq.2	Eq.3	Eq.4	Eq.5	Eq.6	Eq.7	Eq.8
INTERCEPT	–.052 (.441)	.073 (.338)	–.039 (.562)	.048 (.499)	.248 (.001)	.311 (.000)	.171 (.031)	.378 (.000)
BIOLOGIC								
WOMEN'S:								
Parity	.409 (.000)	.369 (.000)	.408 (.000)	.409 (.000)	.346 (.000)	.322 (.000)	.368 (.000)	.317 (.000)
Parity^2	–.022 (.000)	–.020 (.000)	–.022 (.000)	–.022 (.000)	–.021 (.000)	–.020 (.000)	–.020 (.000)	–.020 (.000)
DURATION								
Married 5–9 yr	–.196 (.000)	–.203 (.000)	–.195 (.000)	–.196 (.000)	–.119 (.027)	–.124 (.022)	–.202 (.000)	–.127 (.020)
Married 10–14 yr	–.214 (.000)	–.226 (.000)	–.216 (.000)	–.217 (.000)	–.165 (.005)	–.169 (.004)	–.226 (.000)	–.173 (.004)
HEALTH INTER-VENTIONS								
UPGK:								
Had growth card		–.270 (.001)	–	–	–	–.157 (.058)	–.256 (.002)	–.141 (.087)
Growth× Parity		.072 (.000)	–	–	–	.049 (.011)	.072 (.000)	.048 (.012)
ORT								
Have Oralit			–.201 (.002)	–	–	–	–	–.171 (.009)
ANC								
ANC 1–3 times				–.101 (.041)	–	–	–.106 (.033)	–.067 (.181)
ANC $\geq$4 times				–.163 (.000)	–	–	–.165 (.000)	–.105 (.005)
FAM. PLANNING								
Acceptor					–.713 (.000)	–.686 (.000)	–	–.661 (.000)
Accept.×Parity					.127 (.000)	.118 (.000)	–	.120 (.000)
F Model ($Prob \geq F$)	129.8 (.000)	89.0 (.000)	105.8 (.000)	90.2 (.000)	103.1 (.000)	78.3 (.000)	69.5 (.000)	58.5 (.000)
R^2 %	4.9	5.1	5.0	5.2	5.9	6.0	5.3	6.1
No. of cases (Births)	9898	9898	9898	9898	9898	9898	9898	9898

increases the risk of death.

These two problems cannot be resolved by creating MI, although the MI have automatically been adjusted for women's parity and the marital duration. We deal with these problems in two ways. First, our analysis was restricted to the marital duration up to 15 years, so that the exogenous mortality decline and some socioeconomic trend effects beyond the past 15 years could be minimized in the model. Second, we also included exposure groups (*i.e., dummy covariates such as the marital duration* $5-9$ *and* $10-14$ *years in contrast to* $0-4$ *years*) and women's parity in the model, to pick up trend effects not associated with the main explanatory variables being examined. To pick up a nonlinear trend associated with parity, the quadratic term of parity is included in the model as an adjustment factor.

However, restricting the marital duration up to 15 years may result in a concentration of high risk coming from the first births or younger mother's age in the reference group (*0 to 4 years*)[2]. Under this condition we should expect the highest risk of having a dead child in the category of marital duration $0-4$ years. Thus if the category of marital duration between $0-4$ is a reference category, the two other categories should have lower MIs.

To simplify our presentation, OLS models are presented in the tabular form. There are 8 models in Table 6.6. A model is presented in each column of the table. Consider column 2 of Table 6.6 (*heading eq.1 or equation 1*), the OLS model presents effects of parity and duration of marriage as explanatory variables for MI. From equations 2 to 8 (*columns 3–9*), we obtained estimates of effects of child survival interventions adjusted for biological factors (*women's parity and marital*

[2]Especially given a current decline of fertility level in this sample as presented in the population pyramid in Figure 5.1

duration). At the bottom of the table, the F–test for overall model, coefficient of determination (R^2 *in percent*), and number of cases (*births*) are presented. For example, equation 1 (*column 2*) give model estimates as follows:

$\hat{MI} = -0.052 + 0.409$**Parity** -0.022 **Parity**^{2}

-0.196(**Marital duration** $5-9$ **year**)

-0.214(**Marital duration** $9-14$ **year**),

where F model =129.8 (*P=0.000*), $R^2 = 4.9\%$, and N-cases = 9898. It should be noted that as part of the model specification, we always test the possibility of significant interactions among explanatory variables.

Intervention Effects Adjusted for Duration of Marriage and Parity

The OLS model 1 (*eq.1*) of Table 6.6 (*page 191*) suggests the importance of parity and duration of marriage as explanatory variables. From the bottom panel, the F–test shows that these two variables are statistically significant in the model. Based on the coefficient determination (R^2), these variables account for about 4.9 percent of total variation in the model. But, caution must be given here since the model specification (*i.e., link function*) may not be appropriate, which is likely given the very low R^2 value. Therefore we should examine the absolute value of parameter estimates (*slope*) of the model and compare each parameter estimate to zero (*Wald's statistics*).

As we can see in equation 1, increasing parity will increase the MI nonlinearly. More precisely, the effect will be reduced at the higher parity.[3] The effect of woman's parity (*as a continuous covariate*) is weakening with the increasing number of CEB.

The category of marital duration between $5-9$ years has a lower

[3] Parity square has a negative value.

MI compared with the reference category (*married* $0-4$ *years*). The marital duration category $10-15$ years has a much lower MI than category the $5-9$ years. This result shows that the reference category has a higher risk of having a dead child. Table 6.6 (*column 2*) shows the association between MI and the availability of a growth card within the household as a proxy for adoption of the growth monitoring (*UPGK*) program. Different from Table 6.5, this parameter estimate has been adjusted for women's parity, marital duration, and an interaction between women's parity and UPGK. Using partial F–test, the result suggests that it is necessary to retain an interaction term between UPGK and parity in the model. The estimate of this interaction term is significantly different from zero. More importantly, in contrast with an unadjusted (*gross*) effect of this variable in Table 6.5, we see a significant association between the growth card variable and MI, although this depends on the women's parity (*CEB*). Women who had a growth card at home tend to have a lower MI compared with those who did not have a growth card. But, the interaction term has a positive sign. This suggests that the stronger association is found in the lower parity. Indeed, the association with a growth card variable (*UPGK*) will be diminished when women's parity approache 4 children. Moreover, it goes in the other direction when parity is above four.

Equation 3 (*column 4 Table 6.6*) shows a parameter estimate of availability of ORT within household, adjusted for women's parity and marital duration. A negative coefficient of parameter suggests that women who had ORT at home have a lower MI than women without ORT at home. The adjustment to women's parity and a marital duration changes the gross–effect association presented in Table 6.5. When both parity and marital duration were not considered in the model, there was no association between the availability of ORT at home and MI.

Equation 4 shows that women with ANC $1-3$ times have a lower MI than women who never had ANC, after adjusting for women's parity and marital duration. If women had ANC 4 times or more, the MI is lower than women who had ANC $1-3$ times. There were no significant interactions between ANC and other variables, including an interaction with women's parity. The result suggests that frequent ANC may be an indicator of a greater degree of awareness to a modern health service, which may imply a lower risk of mortality.

Women who ever used modern contraceptive methods (*acceptor*) have a lower MI than women who never used a contraceptive method, even after adjusting for women's parity and marital duration. However, the association becomes weaker with increasing parity. There is no a significant interaction between the variables of contraceptive use and parity or marital duration.

The adoption of growth monitoring may be associated with the use of other potential child survival interventions. A comparison between equations 2 and 6 shows the extent to which growth monitoring effects are due to an association of growth monitoring with the use of contraceptive method, adjusting for women's parity and marital duration. Similarly, a comparison of equations 2 and 7 suggests the extent to which growth monitoring effects are due to the association of growth monitoring with the ANC variable.

Besides partial F–test and R^2 improvements, the degree of association among explanatory variables may be examined by looking at the size of parameters before and after adjustment was made. For example, the estimated effect of growth card reduces from $-.270$ to

$-.157$, after an acceptor variable is included in the model. This shows that the effect of UPGK is confounded by the acceptor variable. One may infer that the participation of women in UPGK may increase the probability of being an acceptor of family planning. But acceptors may have a social organization, which runs UPGK program. Therefore it is also possible that family planning program increases the adoption of UPGK.

A comparison between equations 2 and 7 does not strongly suggest that participants of UPGK are more likely to have ANC. The change of the parameter estimate of UPGK, before and after adjusting for ANC, does not suggest that the ANC variable is a confounding factor for UPGK (*slopes before and after adjustment are* $-.270$ *and* $-.256$ *respectively*). If UPGK, ORT, ANC, and contraceptive use are included in the model, the acceptor variable still shows a very strong independent association with MI. Other interventions are also associated with the MI, except ANC $1 - 3$ becomes insignificant.

From a comparison of parameter estimates across columns, suggests that the effects UPGK on MI is partly through the improvement of modern health services utilization, mainly contraception. Interestingly, UPGK has an independent effect other than to increase modern health service utilization.

It should be noted, however, that these associations have not been adjusted for socioeconomic variables in the model, including the variations of health services in the study area. Therefore, following analyses will adjust for socioeconomic and health services variables in the models.

Intervention Effects Adjusted for Marital Duration, Parity, and Socioeconomic Variables

Table 6.7(*pages 199 – 200*) shows adjustments for the intervention effects from both biologic and socioeconomic status (*SES*). Comparison between equation 1 (*column 1*) and equation 2 (*column 2*) shows the extent to which the intervention effects are confounded by mother's health knowledge. Although coefficients of growth card and ORT are changing, only the dummy variable ANC is strongly associated with the knowledge of immunization. The data suggest that women who ever had ANC are likely to have ever heard the word immunization (*because they were more likely had children immunized and are more knowledgeable in health matters*), but the independent effects of ANC become not significant. At this stage, the effects attributed to ORT and acceptor variables decrease, but are still statistically significant.

Equations 3 shows the effects of interventions adjusted for women's parity, duration of marriage, and mother's education. Similarly, besides parity and marital duration, intervention effects in equations 4, 5, 6, and 7 are individually adjusted for the availability of latrine facilities, husband's education, husband's occupation, and family income respectively (*in log Rupiah*). Simultaneous adjustment of these socioeconomic variables is presented in equation 8.

The results of adjusting to socioeconomic variables on intervention effects (*on given row*) can be compared across columns 2 to 9. For example, the estimated effect of growth card adjusted for immunization knowledge changes from $-.141$ to $-.128$, and it becomes $-.164$ after adjustment for mother's education. This coefficient is finally $-.152$ (*column 9*) after all variables are included in the model. From the Table 6.7, we may conclude that women's participation in UPGK and a family planning program (*acceptor*) may reduce risks of having a child dead, but this still depends on their parity. For example, because the interaction terms with parity, women with parity three or more and never participated in UPGK are likely to have a high risk of having a child dead Similarly, women with parity five or more and never used contraception are also likely to have a child dead.

The effects of ORT and ANC variables are diminished by SES variables. The coefficient estimates of these variables are statistically not different from zero. However, knowledge of immunization, women's or husband's education being secondary and above, availability of a latrine (*especially flush latrine/with septic tank*), husband as *pegawai negeri* or *ABRI*, and log household expenditures in Rupiah (*proxy for household incomes*) are still statistically significant, even though considered to be intervention and biologic factors in the models.

A more formal testing of the effects of these SES variables can be done by comparing equations 1 and 2 in Table 6.8 (*pages 202–203*) (*column 2 and 3*). There were no changes of estimates of these SES variables before and after intervention factors are included in the model. This suggests that SES variables have independent effects on mortality index.

Intervention Effects of Macro Variables Adjusted for Duration of Marriage, Parity, and Socioeconomic Variables

Table 6.8 examines the effects of macro variables (*strength of health and family planning program, distance to PHC, and the infrastructure developments at PHC level*), but excludes effects of child survival interventions at the micro level.

Equation 3 suggests that proportion of immunized children at

Table 6.7: ESTIMATED COEFFICIENTS OF MULTIPLE REGRESSIONS OF VARIABLES INTERVENTIONS ON MI AND THEIR P VALUES ADJUSTED TO SES VARIABLES FOR MARRIAGE < 15 YEARS

VARIABLES	Eq.1	Eq.2	Eq.3	Eq.4	Eq.5	Eq.6	Eq.7	Eq.8
INTERCEPT	.378 (.000)	.443 (.000)	.476 (.000)	.542 (.000)	.441 (.000)	.463 (.000)	2.032 (.000)	1.751 (.000)
BIOLOGIC								
WOMEN'S:								
Parity	.317 (.000)	.315 (.000)	.320 (.000)	.311 (.000)	.323 (.000)	.326 (.000)	.320 (.000)	.317 (.000)
Parity ^{2}	–.020 (.000)	–.019 (.000)	–.020 (.000)	–.019 (.000)	–.020 (.000)	–.020 (.000)	–.019 (.000)	–.019 (.000)
DURATION								
Married 5–9 yr	–.127 (.020)	–.128 (.016)	–.171 (.002)	–.124 (.022)	–.149 (.006)	–.153 (.005)	–.144 (.008)	–.167 (.002)
Married 10–14 yr	–.173 (.004)	–.180 (.002)	–.230 (.000)	–.169 (.004)	–.205 (.000)	–.198 (.000)	–.191 (.001)	–.215 (.000)
HEALTH INTER–VENTIONS								
UPGK:								
Growth Card	–.141 (.087)	–.128 (.121)	–.164 (.050)	–.130 (.115)	–.163 (.048)	–.173 (.036)	–.157 (.057)	–.152 (.064)
Growth × Parity	.048 (.012)	.052 (.007)	.051 (.008)	.042 (.030)	.053 (.000)	.054 (.005)	.050 (.009)	.050 (.009)
ORT:								
Had oralit	–.171 (.009)	–.143 (.030)	–.089 (.180)	–.110 (.095)	–.124 (.006)	–.090 (.171)	–.126 (.055)	–.026 (.695)
A N C:								
ANC 1–3 times	–.067 (.182)	–.038 (.447)	–.060 (.232)	–.045 (.374)	–.062 (.061)	–.062 (.214)	–.059 (.234)	–.021 (.670)
ANC 4 times –plus	–.105 (.005)	–.053 (.162)	–.030 (.436)	–.064 (.087)	–.069 (.214)	–.023 (.547)	–.067 (.074)	–.028 (.482)
FAM. PLANNING								
Acceptor	–.661 (.000)	–.646 (.000)	–.643 (.000)	–.645 (.000)	–.646 (.073)	–.646 (.000)	–.670 (.000)	–.630 (.000)
Accept. × Parity	.120 (.000)	.122 (.000)	.122 (.000)	.119 (.000)	.121 (.000)	.121 (.000)	.123 (.000)	.125 (.000)
MOTHER								
KNOWLEDGE:								
immunization		–.188 (.000)	–	–	–	–	–	–.120 (.000)
EDUCATION:								
Some primary			–.085 (.085)	–	–	–	–	–.035 (.500)
Primary			–.062 (.138)	–	–	–	–	–.027 (.543)
Secondary +			–.490 (.000)	–	–	–	–	–.269 (.000)
(Continued on next page)								

Table 6.7: CONTINUED

VARIABLES	Eq.1	Eq.2	Eq.3	Eq.4	Eq.5	Eq.6	Eq.7	Eq.8
FAMILY:								
LATRINE								
Pit latrine				–.184 (.000)	–	–	–	–.163 (.000)
Flush latrine				–.579 (.000)	–	–	–	–.308 (.000)
HUSBAND'S EDUCATION								
Some primary					–.106 (.035)	–	–	–.068 (.204)
Primary					–.028 (.525)	–	–	.028 (.569)
Secondary +					–.239 (.001)	–	–	.139 (.027)
HUSBAND'S OCCUPPATION								
Private						–.077 (.287)	–	–.085 (.268)
Civil/Army						–.507 (.000)	–	–.363 (.000)
EXPENDITURES								
Log in Rp.							–.158 (.000)	–.102 (.000)
F Model (Prob≥F)	58.5 (.000)	56.2 (.000)	52.2 (.000)	54.5 (.000)	48.2 (.000)	56.4 (.000)	58.9 (.000)	36.2 (.000)
R ^{2} %	6.1	6.4	6.8	6.7	6.4	6.9	6.6	7.8
No. of cases (Births)	9898	9898	9898	9898	9898	9898	9898	9898

Note: The coefficients of each categorial variable represents contrast with categories deleted.

PHC (*as the proxy for health program strength*) shows an inverse relationship with the MI. Higher proportion of immunized children is associated with lower MI, even after adjusting for biologic factors, SES variables, and the availability of PHC within area (*log distance in kilometers to PHC from home*). Similarly, the strength of family program (*measured as the proportion of MWRA at PHC level ever used modern contraception*) shows an inverse relationship with the MI (*equation 4*).

Further adjustment on regional developments (*measured as the percentage of village at PHC with asphalt road*) to both health and family planning program strength are presented in equations 5 and 6 respectively. The health program effect is diminished by this adjustment, but the family planning effect still shows a strong association. Similar patterns of these associations can be seen in equations 7 and 8. We may conclude that an increase in the strength of family planning program and the infrastructure development at the macro level could be linked to lower mortality. How these variables affect MI will be pursued in the next analyses.

There is "a statistical multilevel issue" in this equation that should ideally be considered in the parameter estimation. Some variables are derived directly from aggregate levels (*macro variable*), and may result in a bias in the parameter estimate. Therefore, interpretations of these parameter estimates have to be done with caution (*Hermalin, 1986; Mason and Wong, 1981*). It is possible that statistical multilevel issues do not arise in this data set. One approach to detect the existence of such problems would be to the test interaction between micro and macro variables in the model (*Hermalin, 1986*). We tested all possible interactions between micro and macro variables (*results are not shown*). There was no a significant interaction found in these data. This may suggest that the multilevel issue is not a serious problem here.

Table 6.8: ESTIMATED COEFFICIENTS OF MULTIPLE REGRESSIONS OF SES VARIABLES ON MI AND THEIR P VALUES FOR MARRIAGE < 15 YEARS

VARIABLES	Eq.1	Eq.2	Eq.3	Eq.4	Eq.5	Eq.6	Eq.7	Eq.8
INTERCEPT	1.751 (.000)	1.415 (.000)	1.475 (.000)	1.750 (.000)	1.364 (.000)	1.638 (.000)	1.763 (.000)	1.642 (.000)
BIOLOGIC								
Parity	.317 (.000)	.420 (.000)	.421 (.000)	.417 (.000)	.427 (.000)	.421 (.000)	.416 (.000)	.422 (.000)
Parity ^{2}	–.019 (.000)	–.023 (.000)	–.023 (.000)	–.023 (.000)	–.024 (.000)	–.023 (.000)	–.023 (.000)	–.023 (.000)
DURATION								
Married 5–9 yr	–.167 (.002)	–.229 (.000)	–.230 (.000)	–.223 (.000)	–.233 (.000)	–.226 (.000)	–.224 (.000)	–.227 (.000)
Married 10–14 yr	–.215 (.000)	–.252 (.000)	–.248 (.000)	–.239 (.000)	–.253 (.000)	–.243 (.000)	–.239 (.000)	–.244 (.000)
HEALTH INTERVENTIONS								
UPGK:								
Growth Card	–.152 (.064)	–	–	–	–	–	–	–
Growth × Parity	.050 (.009)	–	–	–	–	–	–	–
ORT:								
Had oralit at home	–.026 (.695)	–	–	–	–	–	–	–
A N C:								
ANC 1–3 times	–.021 (.670)	–	–	–	–	–	–	–
ANC 4 times+	.028 (.482)	–	–	–	–	–	–	–
FAM. PLANNING								
Acceptor	–.630 (.080)	–	–	–	–	–	–	–
Accept. × Parity	.125 (.000)	–	–	–	–	–	–	–
MOTHER								
KNOWLEDGE:								
Immunization	–.120 (.000)	–.122 (.000)	–.117 (.000)	–.111 (.002)	–.117 (.000)	–.107 (.002)	–.113 (.001)	–.113 (.001)
EDUCATION:								
Some primary	–.035 (.500)	–.031 (.552)	–.011 (.835)	–.002 (.974)	–.012 (.819)	–.001 (.992)	–.001 (.976)	.000 (.992)
Primary	–.027 (.543)	–.023 (.613)	–.010 (.821)	–.010 (.820)	–.019 (.678)	–.004 (.931)	–.010 (.829)	.001 (.988)
Secondary +	–.269 (.000)	–.276 (.000)	–.238 (.000)	–.207 (.004)	–.227 (.002)	–.196 (.006)	–.211 (.004)	–.203 (.005)
(Continued on next page)								

Table 6.8: CONTINUED

VARIABLES	Eq.1	Eq.2	Eq.3	Eq.4	Eq.5	Eq.6	Eq.7	Eq.8
FAMILY:								
LATRINE:								
Pit latrine	–.163 (.000)	–.184 (.000)	–.198 (.000)	–.178 (.000)	–.200 (.000)	–.187 (.000)	–.174 (.000)	–.178 (.000)
Flush latrine	–.308 (.000)	–.348 (.000)	–.378 (.000)	–.372 (.000)	–.372 (.000)	–.370 (.000)	–.371 (.000)	–.367 (.000)
HUSBAND'S EDUCATION								
Some primary	–.068 (.204)	–.073 (.177)	–.090 (.100)	–.089 (.104)	–.089 (.103)	–.089 (.104)	–.089 (.105)	–.088 (.108)
Primary	.028 (.569)	.025 (.646)	.016 (.741)	.012 (.806)	.020 (.677)	.018 (.722)	.010 (.831)	.015 .767
Secondary +	.139 (.027)	.137 (.030)	.131 (.040)	.118 (.064)	.143 (.025)	.128 (.044)	.116 (.067)	.128 (.044)
HUSBAND'S OCCUPATION								
Private	–.085 (.268)	–.130 (.090)	–.122 (.144)	–.115 (.137)	–.132 (.086)	–.124 (.108)	–.114 (.141)	–.124 (.110)
Civil/Army	–.363 (.000)	–.400 (.000)	–.368 (.000)	–.354 (.000)	–.358 (.000)	–.339 (.000)	–.360 (.000)	–.352 (.000)
EXPENDITURES								
Log in Rp	–.102 (.000)	–.097 (.000)	–.099 (.000)	–.104 (.000)	–.089 (.000)	–.096 (.000)	–.105 (.000)	–.096 (.000)
HEALTH– FP SERVICES AT PHC LEVEL								
Prop. children immunized			–.238 (.095)	–	–.026 (.871)	–	.106 (.520)	.304 (.089)
Prop. .MWRA as acceptor FP			–	–.631 (.000)	–	–.509 (.000)	–.685 (.000)	–.625 (.000)
AVAILABILITY SERVICES								
Distance to PHC (log km)			–.006 (.716)	–.009 (.568)	–.010 (.517)	–.013 (.398)	–.008 (.618)	–.012 (.465)
INFRASTRUCT. DEVELOPMENT								
Prop. villages had asphalt road			–	–	–.222 (.000)	–.148 (.016)	–	–.191 (.004)
F Model (Prob≥F)	36.3 (.000)	46.3 (.000)	41.3 (.000)	42.3 (.000)	39.8 (.000)	40.4 (.000)	40.1 (.000)	38.5 (.000)
R ^{2} %	7.8	7.0	7.1	7.2	7.2	7.3	7.2	7.3
No. of cases (Births)	9898	9898	9810	9810	9810	9810	9810	9810

Note: The coefficients of each categorial variable represents contrast with categories deleted.

Intervention Effects Adjusted for Micro and Macro Variables

Table 6.9 (*pages 205 – 206*) shows similar analyses in Table 6.7, except that variable interventions at the individual level are simultaneously adjusted for macro variables. An adjustment on the variables of health program strength and availability of services is presented in equation 2 of Table 6.9. Further adjustment of this model for regional development variables is presented in equation 3. Equations 4 and 5 consider family planning program, availability of health care facilities, and regional development variables in the model, while equation 6 excludes the regional development variable from the model. In equation 7, all variables in the model are considered.

To examine the intervention effects as a result of adjusting for each macro variable can be done by comparing parameter estimates across columns. The data show that the results of previous findings in Table 6.7 hold in these models. Namely, only UPGK, family planning program, and possibly immunization programs (*based on ever heard immunization*) show independent effects after being adjusted for other micro and macro variables.

Similarly, to examine the effect of SES variables, one can compare parameter estimates across columns. In general, the effect of adjusting for macro variables does not change the previous conclusions. The results also indicate that the family planning program and infrastructure development are very important determinants of mortality.

Table 6.9: ESTIMATED COEFFICIENTS OF MULTIPLE REGRESSIONS OF ALL VARIABLES ON MI AND THEIR P VALUES FOR MARRIAGE <15 YEARS

VARIABLES	Eq.1	Eq.2	Eq.3	Eq.4	Eq.5	Eq.6	Eq.7
INTERCEPT	1.751 (.000)	1.824 (.000)	1.712 (.000)	2.042 (.000)	1.914 (.000)	2.042 (.000)	1.918 (.000)
BIOLOGIC							
WOMEN'S:							
Parity	.317 (.000)	.316 (.000)	.324 (.000)	.311 (.000)	0.318 (.000)	.311 (.000)	.319 (.000)
Parity ^{2}	–.019 (.000)	–.020 (.000)	–.020 (.000)	–.019 (.000)	–.020 (.000)	–.019 (.000)	–.020 (.000)
DURATION							
Married 5-9 yr	–.167 (.002)	–.169 (.002)	–.173 (.002)	–.169 (.002)	–.171 (.001)	–.169 (.002)	–.173 (.002)
Married 10-14 yr	–.215 (.000)	–.213 (.000)	–.219 (.000)	–.210 (.000)	–.215 (.000)	–.210 (.000)	–.216 (.000)
HEALTH INTER-VENTIONS							
UPGK :							
Growth Card	–.152 (.064)	–.161 (.053)	–.169 (.042)	–.159 (.055)	–.167 (.044)	–.159 (.055)	–.167 (.044)
Growth $\times$ Parity	.050 (.009)	.052 (.007)	.050 (.010)	.051 (.009)	.050 (.009)	.051 (.009)	.049 (.011)
ORT							
Had oralit	–.026 (.695)	–.031 (.640)	–.035 (.603)	–.040 (.550)	–.043 (.522)	–.040 (.550)	–.042 (.527)
A N C							
ANC 1-3 times	–.021 (.670)	–.029 (.572)	–.006 (.910)	–.004 (.944)	–.006 (.900)	–.004 (.944)	–.014 (.780)
ANC 4 times +	.028 (.482)	–.036 (.372)	–.044 (.281)	–.040 (.317)	.050 (.210)	–.040 (.321)	–.046 (.250)
FAM. PLANNING							
Acceptor	–.630 (.000)	–.620 (.000)	–.624 (.000)	–.589 (.000)	–.600 (.000)	–.589 (.000)	–.596 (.000)
Accept. $\times$ Parity	.125 (.000)	.125 (.000)	.126 (.000)	.124 (.000)	.125 (.000)	.124 (.000)	.125 (.000)
MOTHER							
KNOWLEDGE:							
Immunization	–.129 (.000)	–.116 (.001)	–.115 (.002)	–.118 (.001)	–.113 (.002)	–.118 (.001)	–.117 (.001)
EDUCATION:							
Some primary	–.035 (.500)	–.017 (.746)	–.018 (.724)	–.009 (.869)	–.010 (.848)	–.009 (.869)	–.011 (.836)
Primary	–.027 (.543)	–.017 (.712)	–.024 (.596)	–.002 (.963)	–.009 (.843)	–.002 (.963)	–.010 (.822)
Secondary +	–.269 (.000)	–.235 (.001)	–.224 (.002)	–.215 (.003)	–.204 (.005)	–.215 (.003)	–.207 (.004)
(Continued on next page)							

Table 6.9: CONTINUED

VARIABLES	Eq.1	Eq.2	Eq.3	Eq.4	Eq.5	Eq.6	Eq.7
FAMILY:							
LATRINE:							
Pit latrine	–.163 (.000)	–.175 (.000)	–.178 (.000)	–.162 (.000)	–.171 (.000)	–.162 (.000)	–.166 (.000)
Flush latrine	–.308 (.000)	–.335 (.000)	–.333 (.000)	–.334 (.000)	–.333 (.000)	–.334 (.000)	–.332 (.000)
HUSBAND'S EDUCATION							
Some primary	–.068 (.204)	–.086 (.118)	–.085 (.122)	–.086 (.117)	–.085 (.118)	–.086 (.117)	–.085 (.121)
Primary	.028 (.569)	.020 (.683)	.024 (.628)	.016 (.751)	.021 (.672)	.016 (.752)	.019 (.693)
Secondary +	.139 (.027)	.131 (.040)	.143 (.025)	.119 (.063)	.131 (.041)	.119 (.063)	.131 (.040)
HUSBAND'S OCCUPATION							
Private	–.085 (.268)	–.078 (.312)	–.088 (.255)	–.078 (.312)	–.087 (.262)	–.078 (.312)	–.087 (.261)
Civil/Army	–.363 (.000)	–.334 (.000)	–.324 (.000)	–.333 (.000)	–.316 (.000)	–.333 (.000)	–.324 (.000)
EXPENDITURES							
Log in Rp.	–.102 (.000)	–.104 (.000)	–.095 (.000)	–.109 (.000)	–.100 (.000)	–.109 (.000)	–.100 (.000)
HEALTH-FP SERVICES AT PHC LEVEL							
Prop. children immunized		–.261 (.072)	–.001 (.996)	–	–	.001 (.997)	.210 (.250)
Prop. MWRA as acceptor FP			–	–.527 (.000)	–.387 (.014)	–.527 (.002)	–.471 (.007)
AVAILABILITY OF SERVICES							
Distance to PHC (log km)		–.012 (.443)	–.016 (.304)	–.013 (.405)	–.018 (.257)	–.013 (.408)	–.017 (.219)
INFRASTRUCT. DEVELOPMENT							
Prop. villages had asphalt road			–.217 (.001)	–	–.166 (.008)	–	–.196 (.004)
F Model (Prob $\geq$ F)	36.3 (.000)	33.2 (.000)	32.3 (.000)	33.6 (.000)	32.6 (.000)	32.3 (.000)	31.4 (.000)
R^2 (pct)	7.8	7.8	7.9	7.9	8.0	7.9	8.0
No. of cases (Births)	9898	9810	9810	9810	9810	9810	9810

Note: The coefficients of each categorial variable represents contrast with categories deleted.

Parsimonious Models for OLS

Table 6.10 (*page 208*) equations 1, 2, and 3, show the intervention effects after the number of parameters in the models have been reduced. Besides retaining UPGK and family planning variables and their interaction terms with parity, there were also other variables included in the model that were recategorized based on the findings presented in previous analyses. For example, maternal education is recategorized into *below secondary* and *secondary and above*, while father's occupation into *pegawai negeri* or *ABRI* and *other*. Variable latrine is also reclassified into two categories: category "had flush latrine or with septic tank" and "other". based on the findings presented in previous analyses.

In equation 1, availability of growth card and ever use contraception are adjusted for variable parity (*including the quadratic terms or parity square*), health knowledge on immunization (*heard the word immunization*), maternal education, father's occupation, and income. The data clearly show that women who have ever come to the UPGK program have a lower probability of having a child death than those who have never come to UPGK. Similarly, women who ever used contraception have lower infant and child mortality risks than women never use contraception. However, both effects of participating on UPGK and family planning program are conditioned by parity. Namely, the effects are greater among lower parity than higher parity women.

Besides an association with the health knowledge, one may consider that ever heard of immunization is a proxy for child immunization status. For example, women who ever heard the word immunization may actually have had their children immunized. We did not have information for all children ever immunized at this stage of analysis.

Table 6.10: ESTIMATED COEFFICIENTS OF MULTIPLE REGRESSIONS OF SELECTED VARIABLES ON MI AND THEIR P VALUES FOR MARRIAGE <15 YEARS

VARIABLES	Equation No. 1	Equation No. 2	Equation No. 3
INTERCEPT	1.488 (.000)	1.790 (.000)	1.688 (.000)
Parity	.322 (.000)	.315 (.000)	.320 (.000)
Parity ^{2}	–.020 (.000)	–.020 (.000)	–.020 (.000)
Married 5–9 yr	–.173 (.001)	–.176 (.001)	–.178 (.001)
Married 10–14 yr	–.225 (.000)	–.221 (.000)	–.225 (.000)
Growth Card	–.174 (.033)	–.179 (.030)	–.185 (.026)
Growth $\times$ Parity	.054 (.005)	.054 (.005)	.054 (.005)
Acceptor	–.635 (.000)	–.590 (.000)	–.596 (.000)
Accept.$\times$Parity	.124 (.000)	.124 (.000)	.124 (.000)
Heard the word Immunization	–.115 (.000)	–.110 (.002)	–.106 (.003)
Mother' Educ. Secondary+	–.203 (.000)	–.172 (.003)	–.158 (.006)
Had Flush Latrine	–.151 (.029)	–.179 (.010)	–.172 (.013)
Husband Civil/army	–.212 (.000)	–.186 (.000)	–.164 (.003)
Expenditure In Log RP.	–.098 (.000)	–.103 (.000)	–.096 (.000)
Prop. .MWRA as acceptor FP		–.533 (.000)	–.432 (.005)
Prop. villages with asphalt road			–.116 (.057)
F Model (Prob$\geq F$)	61.8 (.000)	57.9 (.000)	54.3 (.000)
R ^{2} (pct)	7.5	7.6	7.7
No. of births	9898	9810	9810

Note: The coefficients of each categorial variable represents contrast with categories deleted.

So these data may suggest that child immunization status may reduce MI.

Equation 2 shows a significant effect of the family planning program macro variable, even after adjusting for the variable ever used a contraceptive method for the individual woman. This suggests that there are indirect effects of family planning program through other means, which are not covered by the individual level variables in this analysis. For example, mothers residing in the PHC–CA with a strong family planning program may be more likely to get treatment for their sick children, because they and many other MWRA knew where the place to get treatment (*place where they get FP methods*) is.[4] Social organizations, which promote family planning program may also take part on the child health promotion. More importantly, women who have already accepted "the Western medical paradigms", may be more aware of the effectiveness of medical technologies on reducing the probability of child death.

Effects of other SES variables (*latrine, maternal education, husband occupation, and income*) show results consistent with previous analyses. These results hold even after we adjusted for the effects of family planning program and regional development at the PHC level. Thus besides the effect of SES mediated through our intervention variables, these factors may operate through other mechanisms, since SES variables have independent effects in the model.

[4] More than 80% of acceptors of contraception received contraceptive methods in the PUSKESMAS or hospitals.

6.6 PROPORTIONAL HAZARD MODEL

In this section, we used data on survival status of children, who were born within the past 5 years. Besides survival status (*deceased or living*) at the time of survey, we reconstructed survival times (*defined in chapter 3*) as a dependent variable. A survival time should be considered as an ordinal variable since we are regrouping survival times into 9 categories. These nine categories represent survival times for the following intervals: $(0-1]$, $(1-3]$, $(3-6]$, $(6-9]$, $(9-12]$, $(12-18]$, $(18-24]$, $(24-36]$, and $(36-60]$. It is assumed that the hazard rate is a constant at each of these intervals. Thus "a proportional hazard model for grouped data", as discussed in chapter 3, will be used in this analysis.

Besides explanatory variables used in previous analysis, some new variables are considered here. We have data on the completeness of immunization, breast–feeding status at last time of follow–up (*either at the time of survey or at the time of death*), and history of TT injection during ANC. These intervention variables are presented in dichotomous scales. A group of children who received an intervention is used as a reference category. The aim of coding–scheme here is to obtain positive estimates of the relative risks among children with a higher risk of dying associated with nonusers of child survival interventions.[5] SES variables are also reconstructed into dichotomies dummy variables. But we do not change the scales of other continuous variables defined in previous analysis.

[5] For example, children who did receive complete immunization is used as a reference category, since this group is expected to lower higher risks of death compared with completely immunized children. So it is expected that the parameter estimate of immunization is greater than zero. Thus an estimate of relative risk (RR) should be greater than unity ($RR = \exp \boldsymbol{\beta}$).

Since our analysis runs under the assumption of a proportional hazard model, we considered testing departures from the assumption of proportionality. Examination of residuals, which is usually applied for a small sample, provides checks on the model. However, in a large sample, formal testing of proportional hazard assumptions can be derived as a parametric test as suggested by Lawless (*1982*). We did some tests of the proportionality assumption in this analysis. The data do not violate the assumptions.

We will examine effects of intervention variables, and then consider a parsimonious model to derive RR estimates. The estimates of RR adjusted for other confounding factors can be calculated from the model discussed in this section. A comparison of RR among different models will be discussed in chapter 8.

6.6.1 Model Comparisons

Intervention Effects Adjusted for Mother's Age at Child's Birth and Birth Order

Table 6.11(*page 212*) shows parameter estimates of intervention variables, adjusted for mother's age at the time of childbirth and child's birth order. Both mother's age and parity are continuous. We also include a quadratic term of parity in the model to capture a nonlinear effect of birth order on child survival.

A positive sign of parameter estimate of mother's age suggests that increasing age at delivery will increase the probability of death of her children. In contrast, a parameter estimate of birth order has a negative sign, but its quadratic term has a positive sign. This suggests that increasing of birth order will decrease the probability of death at lower birth order, but it may increase at higher birth order. First–

Table 6.11: PARAMETER ESTIMATES OF INTERVENTION EFFECTS ON SURVIVAL STATUS ADJUSTED FOR BIOLOGICAL FACTORS† USING A PROPORTIONAL HAZARD REGRESSION MODEL

VARIABLES	Eq.1	Eq.2	Eq.3	Eq.4	Eq.5	Eq.6	Eq.7	Eq.8
MOTHER'S:								
Age at birth	.067 (.000)	.058 (.000)	.067 (.000)	.064 (.000)	.069 (.000)	.066 (.000)	.065 (.000)	.060 (.000)
CHILD'S								
Birth order	–.222 (.005)	–.202 (.009)	–.222 (.005)	–.229 (.004)	–.183 (.017)	–.221 (.005)	–.237 (.003)	–.205 (.010)
(Birth order)^2	.010 (.120)	.009 (.135)	.010 (.121)	.010 (.101)	.006 (.219)	.010 (.125)	.011 (.086)	.009 (.139)
INTERVENTIONS								
UPGK:								
Nonparticipant		1.991 (.000)	—	—	—	—	—	1.744 (.000)
ORT								
No oralit			.027 (.458)	—	—	—	—	–.296 (.135)
IMMUNIZATION								
Not completed				2.019 (.000)	—	—	—	1.265 (.003)
FAM. PLANNING								
Never used					.389 (.014)	—	—	.170 (.173)
TT at ANC								
Never had TT						.103 (.238)	—	–.484 (.001)
BREASTFEEDING								
Had stopped							–.717 (.000)	–.695 (.000)
LR Null Model	1511	1511	1511	1511	1511	1511	1511	1511
LR Model	1493	1377	1493	1472	1490	1493	1477	1351
AIC with $\beta = 0$	54.4	287.3	54.6	95.8	59.8	54.4	86.4	37.8
No. of cases	4715	4715	4715	4715	4715	4715	4715	4715

†*Note: nine intercept parameters are not presented in the table. P values within parenthesis. The coefficients of each categorial variable represent contrast with categories deleted.*

order children will have a higher risk of death compared to those of second birth order and higher. Since the association between parity and mortality have also been shown in many demographic literatures, it will be used as a control variable in this analysis.

Equations 2 to 6 show intervention effects of UPGK, ORT, immunization, a contraceptive use, and TT at ANC for this child. We also adjusted for breast–feeding status at the time of interview or death (*equation 6*). Except parameter estimates of breast–feeding status, all other parameters are greater than zero (*a positive sign*). But only parameter estimates of UPGK (*equation 2*), immunization status (*equation 4*), and contraceptive use (*equation 5*) are statistically significant (*difference from zero with* $P < .05$). Following our coding scheme, we may interpret that children never brought to UPGK have a higher risk of death compared to children ever been brought to UPGK. Here the result has been adjusted for mother's age and parity. The relative risk is more than 7 times higher among nonparticipant compared to participants.[6] This finding holds, even if we consider children who survived at least one year (*results not shown*).

An effect of immunization shows similar risk for the UPGK variable (*equation 4*). The risk of death among children with incomplete immunization is 7.5 times greater than for completely immunized children. But this result may likely to be over estimated since children who have died before 12 months have an upward bias on the risk of death associated to nonimmunized status. Even so, children who survive 12 months or more (*past the schedule–time of immunization*)

[6]The estimates of RR can be derived by taking the exponential of this coefficient, and the 95% confidence interval can be calculated using its standard error. For example, the UPGK has parameter estimate= 1.991 and standard error=0.145, thus $RR = \exp(1.991)$ and the 95% confidence interval= $\exp(1.991 \pm 1.96 \times 1.45)$. Thus the RR estimate in the population lies between 5.5 and 9.7.

still show a similar risk,[7] although the relative risk is somewhat lower than risk all under–5 children (*β reduces from 2.0 to 1.7*).

Consistent with the previous analysis, children whose mother "ever used contraceptive method" have lower risk of death than other children (*equation 5*). When we considered contraceptive use before pregnancy of the children being examined, the relative risks showed no major difference with the model in equation 5 (*number is not shown in the table*).

Children whose mother did not have Oralit (*equation 3*) and did not receive TT during ANC (*equation 6*) showed no increase in the probability of dying compared with their reference categories. It should be noted that TT during ANC may not affect child mortality, since TT immunization prevents only a neonatal tetanus, which commonly occur a few days after birth. Becuase of the limited effect of TT immunization, a survival time up to one year was considered. In this case, the parameter estimates of TT at ANC is 0.427 (SE$= .179$ and P$= 008$) (*result not shown*). This suggests that TT injection during ANC may protect against infant deaths but may not provide equal protection at age one and over.

Breast–feeding status at last time of follow–up (*either survived or dead*) shows a negative parameter estimate for children who had stopped breast–feeding (*equation 7*). It is necessary to interpret carefully the effect of breast–feeding status, because of the issue of a time covariate dependency for this variable. For example, children who survived more than 2 years probably not being breastfed at the time of survey, while those who survived less than one year were certainly more likely to receive a breast–feeding. Both of them are giving effects

[7] In this analysis, by definition children 12 months and above should have received complete immunization: one BCG and 2 DPT injection, 2 times oral polio vaccine.

to survival status that depend on children's age. Originally we had intended to include this time–dependent covariate in the model, but poor data quality on the duration of breast–feeding did not allow us to perform such analysis. [8]

Breast–feeding status is not our main interest, but we include it in this analysis as a control variable. Breast–feeding status is probably an important control variable, especially in the model with nutritional outcome. As stated earlier, we need to have comparability of covariates between mortality and nutritional status models. Thus, despite the problem discussed, we always include this variable in the next models.

Equation 8 shows all intervention variables in the single model, which has been adjusted for mother's age and parity. In this model, parameter estimates of some intervention variables are reduced, or even change signs (*from positive to negative*). The immunization and contraceptive use variable are reduced almost to half their previous sizes, while the signs of parameters for ORT and TT reverse from positive to negative. This clearly suggests that the net impact of immunization is lower than the gross effect, since the parameter estimate of immunization reduces from 2.02 to 1.27.

Only small changes for UPGK parameters occurred in this model. At the same time, the parameter estimate of contraceptive use become significant. This strongly suggests that the independent effect of UPGK exists, besides a part of the effect acts through the utilization of immunization and contraceptive use. This result is similar to

[8] We spent some time examining the data quality to deal with this problem in our modeling. But duration of breast–feeding of children who had died and were born more than 2 years prior to the survey date has serious misreport (*time heaping*). The heaping exists even after survival times are grouped into an ordinal scale.

the result of the OLS method described in the previous section.

The SES variables have not been taken into account in the model. It is possible that SES variables are confounding factors in this model. Therefore adjustment to SES variables is presented in the following section.

Intervention Effects Adjusted for SES Variables

Table 6.12(*page 217 column 1 to 8*)shows effects of intervention variables that also adjusted for confounding variables. These variables are: maternal education, latrine facilities, father's occupation and household's expenditures. It should be noted that mother's age, parity (*including its quadratic term*), and breast–feeding status are included in the model.[9] The result shows that UPGK and immunization are strong determinants of child survival, even after adjusting for biological and SES variables.

It should be noted that all SES variables can be directly linked with mortality (*equations 1, 3, 4, and 5*). However, SES variables show less significant effects after adjusted for intervention variables in the models (*equations 2, 4, 6, and 8*). (*i.e., paramater estimates of maternal education reduces from 0.569 to 0.234*). This means that children from mothers with education less than secondary school have higher risk of death compared with those whose finished secondary school and higher, but RR reduces from 1.8 to 1.3 when intervention variables are included in the models. Similarly, income has a negative of parameter of estimate, which suggests that increasing expenditures (*a proxy*

[9] All intervention effects are adjusted individually to maternal education (*equation 2*), latrine facility (*equation 4*), father's occupation (*equation 6*), and household's expenditures (*equation 8*). We did not put all variables in the single model since the number of parameter estimates has nine additional parameters, which are intercepts of age groups (γ_j where $j = 1, 2, \ldots 9$).

Table 6.12: PARAMETER ESTIMATES OF INTERVENTION EFFECTS ON SURVIVAL STATUS ADJUSTED FOR BIOLOGICAL AND SES FACTORS† USING A PROPORTIONAL HAZARD REGRESSION MODEL

VARIABLES	Eq.1	Eq.2	Eq.3	Eq.4	Eq.5	Eq.6	Eq.7	Eq.8
MOTHER'S:								
Age at birth	.065 (.000)	.059 (.000)	.065 (.000)	.060 (.000)	.065 (.000)	.059 (.000)	.065 (.000)	.059 (.000)
CHILD'S								
Birth order	–.228 (.004)	–.207 (.010)	–.219 (.005)	–.206 (.010)	–.220 (.005)	–.200 (.012)	–.219 (.005)	–.205 (.011)
(Birth order)^2	.010 (.113)	.009 (.136)	.010 (.112)	.009 (.101)	.010 (.121)	.009 (.149)	.010 (.112)	.010 (.137)
INTERVENTIONS								
UPGK:								
Nonparticipant	—	1.739 (.000)	—	1.744 (.000)	—	1.740 (.000)	—	1.744 (.000)
ORT								
No oralit	—	–.310 (.119)	—	–.290 (.135)	—	–.308 (.121)	—	–.296 (.135)
IMMUNIZATION								
Not completed	—	1.219 (.004)	—	1.278 (.003)	—	1.230 (.004)	—	1.245 (.004)
FAM. PLANNING								
Never used	—	.167 (.178)	—	.175 (.168)	—	.167 (.179)	—	.166 (.178)
TT at ANC								
Never had TT	—	–.509 (.000)	—	–.474 (.001)	—	–.511 (.000)	—	–.512 (.001)
BREASTFEEDING								
Had stopped	—	–.692 (.000)	—	–.696 (.000)	—	–.696 (.000)	—	–.690 (.000)
SES VARIABLES:								
MOTHER'S								
Educ.<second.	.569 (.009)	.234 (.171)	—	—	—	—	—	—
LATRINE								
No latrine			.193 (.234)	–.121 (.329)	—	—	—	—
FATHER'S OCCUP.								
Non Civil/Army					.505 (.010)	.198 (.191)	—	—
EXPENDITURES								
Log in Rp.							–.175 (.024)	–.107 (.125)
LR Null Model	1511	1511	1511	1511	1511	1511	1511	1511
LR Model	1490	1351	1493	1351	1490	1351	1491	1491
AIC with $\beta = 0$	61.2	338.8	55.1	338.0	60.7	338.6	58.5	339.5
No. of cases	4715	4715	4715	4715	4715	4715	4715	4715

†*Note: Nine intercept parameters are not presented in the table. P values within parenthesis. The coefficients of each categorial variable represent contrast with categories deleted.*

for income) decrease the probability of dying (*in an exponential scale*). Children with father's occupation other than *a pegawai negeri* or army (*ABRI*) show higher risk of death compared with children with a father in these occupation.[10]

In contrast with the OLS model, the effect of availability of a flush latrine facility is not significant. On the other hand, the estimate of "no flush–latrine" adjusted for biological variables was greater than zero (*positive*), with $\beta = .193$ and SE$= .0234$ (*Equation 3*). Overall, this finding clearly suggest that these SES variables affect child survival through intervention variables.

Intervention Effects Adjusted for Micro and Macro Variables

Table 6.13(*page 219*) shows intervention effects at the macro and micro levels adjusted for mother's age and parity. We did not adjust for SES variables (*at micro level*) in this table for two reasons. First, we have to reduce the number of parameters in the model since the computer program was written with the maximum number of parameters to be less than 20. Besides parameters of interventions, there were nine parameters for age groups, or nine intercepts.[11] Second, adjustments for SES variables in Table 6.12 have been shown, and one may use this table to support a final conclusion.

Equations 1, 3, 5 and 7 show parameter estimates of strength of health program, family planning, local development, and the availability of health services at each PHC respectively. All models have been

[10]We judge from the size of RR and the likelihood ratio test rather than by P values for each coefficient.

[11] Although the computer program can be extended to accommodate more than 20 parameter estimates, we would have to adjust the dimensions of the data–statement and memory array required for this calculation. With a sample size of more than 5,000 children, including the spaces required for data transformation and residual calculation, this would require virtual memory more than 3 megabytes. We can only access virtual memory up to 3 megabytes.

Table 6.13: PARAMETER ESTIMATES OF INTERVENTION EFFECTS ON SURVIVAL STATUS ADJUSTED FOR BIOLOGICAL AND MACRO VARIABLES† USING A PROPORTIONAL HAZARD REGRESSION MODEL

VARIABLES	Eq.1	Eq.2	Eq.3	Eq.4	Eq.5	Eq.6	Eq.7	Eq.8
MOTHER'S:								
Age at birth	.065 (.000)	.061 (.000)	.064 (.000)	.059 (.000)	.065 (.000)	.058 (.000)	.067 (.000)	.060 (.000)
CHILD'S								
Birth order	–.219 (.005)	–.209 (.009)	–.212 (.007)	–.206 (.010)	–.217 (.006)	–.199 (.013)	–.223 (.005)	–.207 (.010)
(Birth order)^2	.010 (.120)	.009 (.136)	.009 (.142)	.009 (.139)	.010 (.123)	.009 (.149)	.010 (.118)	.009 (.136)
INTERVENTIONS								
UPGK:								
Nonparticipant	—	1.762 (.000)	—	1.738 (.000)	—	1.742 (.000)	—	1.751 (.000)
ORT								
No oralit	—	–.304 (.124)	—	–.292 (.133)	—	–.293 (.133)	—	–.292 (.134)
IMMUNIZATION								
Not completed	—	1.310 (.002)	—	1.243 (.004)	—	1.229 (.004)	—	1.251 (.004)
FAM. PLANNING								
Never used	—	.173 (.169)	—	.154 (.197)	—	.168 (.176)	—	.166 (.179)
TT at ANC								
Never had TT	—	–.437 (.000)	—	–.503 (.001)	—	–.516 (.000)	—	–.495 (.001)
BREASTFEEDING								
Had stopped	—	–.695 (.000)	—	–.703 (.000)	—	–.690 (.000)	—	–.693 (.000)
MACRO VARIABLES								
Health Program Immunization	–.617 (.109)	.731 (.080)	—	—	—	—	—	—
Family Planning			–1.134 (.013)	–.594 (.133)	—	—	—	—
Regional Development					–.513 (.011)	–.269 (.115)	—	—
Availability Services							.023 (.352)	.050 (.197)
LR Null Model	1511	1511	1511	1511	1511	1511	1511	1511
LR Model	1492	1350	1490	1351	1490	1351	1493	1351
AIC with $\beta = 0$	56.1	339.8	59.5	339.0	60.2	339.3	54.7	338.5
No. of case	4715	4715	4715	4715	4715	4715	4715	4715

†*Note: Nine intercept parameters are not presented in the table. P values within parenthesis. The coefficients of each categorial variable represent contrast with categories deleted.*

adjusted for mother's age and parity. The availability of health services is measured as the log of distance (*kilometers*) from village to a government health care facility. A PHC with a strong health program or family planning or local development is more likely to have a lower mortality rate. For example, equation 3 shows that an increase in the proportion using family planning reduces the mortality rate, since parameter estimates are below zero (*i.e., negative*). Similarly, increasing the proportion of children immunized and the percentage of villages with asphalt roads will decrease the mortality rate.[12] But the availability of a health services facility shows no independent effect in this area, which is consistent with the previous finding.

Equations 2, 4, 6, and 8 show intervention effects at the micro level adjusted for macro variables. In equation 2, the parameter estimate of health program changes to a positive sign. This suggests that the effect of health program operates only through variable intervention at the micro level. But effects of family planning (*equation 4*) and local development(*equation 6*) show independence associations, after intervention variables included in the model. Negative parameter estimates are shown by these two variables in models 4 and 6.

From this section, we may conclude that child immunization, UPGK participation, and the strength of family planning program at PHC level can be linked directly with child survival. The risk of death among children without completed immunization is 3.5 times higher than among children who were fully immunization. The confidence intervals of the relative risk lies between 1.4 and 8.7. This relative risk was not substantially different from the risks for the sample of children who survived more than one year (*RR=3.1 and 95 percent*

[12] We judge from the size of parameters and the likelihood ratio test rather than by P values for each coefficient.

confidence intervals 2.2 and 9.2). In fact, when we categorized children according to ever or never immunized, the relative risks are only minimally reduced by this new variable (*RR=2.4 and CI*=$1.6-5.6$) (*not presented in the table*). This finding may suggest that immunization status may not be a pure proxy for immunization, but it may be confounded by other medical interventions.

If woman never participated in UPGK her child is at higher risk of death, even after adjusting for other important variables. It suggests that UPGK did not only operate through immunization and contraceptive used, but it may also have operated through other variables not in the model. However, even assuming there was no "recall bias"on the data collection among nonsurvivors, "selection bias" cannot be ruled out with this finding. For example, children with severe growth faltering may not have come to UPGK because their mothers felt embarrassed by their child's weight status. Also, children with a chronic disease may not come to UPGK, either for the same reason or because it may be too sick to come into the UPGK program. These selection biases can increase RR estimates.[13]

Never use contraception shows a small increase in risk of death (*RR=1.2 and 95 percent CI*=$.98-2.1$), after it has also been adjusted for the strength of family planning program. The coefficient of strength of family planning program suggests that children living in the PHC-CA with a strong family planning program have a low risk of death, even with regional development also included in the model. There is an indirect effect of family planning program, which is mediated by other factors but not contraceptive use.

[13] A reference category will likely to have higher risk of death dissociated with UPGK intervention, since healthier children will automatically become the control group.

Mother's education, father's occupation, householdexpenditures, and regional development are important covariates which should be considered in the model. These variables change effects of intervention variables and have direct effects in the model. If these variables are not included in the model, the estimate of intervention effects could be misleading. Thus in evaluating of child survival programs, it is important to consider socioeconomic conditions of the households.

6.7 SUMMARY DETERMINANTS OF MORTALITY

Levels of infant and child mortality in the Timor study are still considered high. Consistent with the previous findings from SUPAS data (*1985*), the mortality level varies between districts. Urban areas show a lower mortality than rural areas, and females show a lower mortality than males.

Although mortality level is still high, there is an obvious trend toward mortality decline in the study area. The declines of infant and child mortality have been sharpening since 1982, which may be associated with the regional development program started in the early 1980's.

Among the child survival interventions introduced in the Timor study, the growth monitoring (*UPGK*), immunization, and family planning program associated with low childhood mortality. But there was no strong evidence that ORT and ANC interventions reduce child mortality.

Using an indirect method, we showed that children from women who ever heard the word immunization have lower mortality rate than children whose mother never heard the word immunization. Further

OLS analysis using Trussell and Preston's method (*1982,1984*) showed consistent results. In a survival analysis, children under 5 who did not receive complete immunization show more than 3 times higher risk of death compared with children who received complete immunization (*one BCG, 2 times DPT, and 2 times polio*). Analyses using macro data support the finding that immunization reduces the mortality rate.

The UPGK program is associated with lower childhood mortality. Besides the effect of UPGK program through increasing of immunization and contraceptive utilization, the UPGK has a strong independent effect on mortality. There is a possibility that participants of UPGK have better knowledge of behavior toward, and access to curative and preventive measures, which could not be included in our analyses. However, we must not rule out the possibility of selection bias associated with this intervention as discussed in a previous section.

Children born to mothers who never used contraception show a more moderate risk of death (*RR=1.2*) than those from mothers who ever used contraception. However, the effect of a family planning program may arise not only through contraceptive use. The independent effect of strength of family program at PHC-CA suggests that family planning program has indirect effects on mortality other than the utilization of contraception. This finding is supported by the indirect method, OLS and survival analysis.

There is no strong evidence that an ANC program has an independent effect on child survival. But TT immunization during ANC improves child survival only up to age one year. Because of the high exposures to risk of death after age one, which is not protected by TT during ANC, the TT effect does not improve survival for one– to five–

year olds.

A comparison between households that lacked access to ORS and households that had access ORT suggests that there is no difference in mortality risks between these two groups. An ORT program may not give a satisfactory result since only a few households can have access to ORS (*about 4 percent of total households*). Forty–three percent of child deaths within the past 5 years can be associated with diarrhea symptoms. Thus, there is still a considerable number of deaths that can be prevented by ORT.

The independent effects of mother's education, father's occupation, household income, and regional development are shown in most analyses. The effects of availability a latrine may not be directly associated with better environmental conditions. The effect of a latrine is diminished in the survival analysis model, after adjustment for other socioeconomic variables. Household expenditures, as a measure of level of income, show a significant inverse association with the mortality rate in most analyses. Although these variables are not our main interest, they should be included in the model since they are confounding variables. Similarly, parity or birth order, and mother's age or duration of marriage should be included in the model for the same reasons.

In general, all findings are supported by the indirect estimation technique, by OLS using Trussell and Preston's method (*1982, 1984*), and by survival analysis. Although these techniques do not necessarily use the same explanatory variables, there is a consistent finding on the association between mortality indices and concepts measured. Thus all techniques applied here may be used for the assessment of the impact of child survival interventions on mortality.

Chapter 7

PREVALENCE AND DETERMINANTS OF GROWTH FALTERING

7.1 INTRODUCTION

This chapter presents the results of bivariates and multivariable analyses on determinants of nutritional status at the aggregate and individual levels. The dependent variables are derived from there nutritional–status indicators weight–for–age, height–for–age, and weight–for–height. These nutritional indicators are measured in Z–scores that are standardized by the median value for the National Center for Health Statistics and Center for Disease Control reference population (*Jordan, 1987; Dibley et al., 1987a; 1987b*).

Z–scores were calculated by subtracting the weight for each child in the sample from the reference value for a child of that particular age and sex, and dividing the difference by the standard deviation of reference population. A similar calculation was performed for height for age. For weight–for–height, Z–scores were computed by subtracting the weight for each child in the sample from the reference value for a child of that height and sex, and dividing the difference by the standard deviation of the reference population (*Waterlow et al., 1977; WHO Working Group, 1986*; Mora, 1989). We also use percentages from a median population, such as a Gomez's classification for a comparative purpose with previous studies (*Gomez, 1956*).

To develop meaningful indicators of nutrition and health status, growth faltering is often presented in a dichotomous scale, i.e., normal or underweight, normal or stunted, and normal or wasted. Sometimes one uses combination of these classifications to distinguish children who have stunted growth and are wasting, with other categories.

"Underweight" is used here to show children whose weight is less than 2 standard deviations below the mean weight–for–age reference value. This is somewhat lower than on the Gomez's classification to second and third degrees of malnutrition (*Gomez, 1956*). Using this terminology, a child who is short or very thin, or both short and thin can be classified as underweight, since this index does not distinguish between thinness and shortness.

"Stunting" refers to children whose height is less than 2 standard deviations below the mean height–for–age reference value. Stunting signifies slowing skeletal growth and is usually associated with chronic malnutrition.

"Wasting" refers to children whose weight is less than 2 standard deviations below the mean weight–for–height reference value. Wasting indicates a deficiency in tissue and fat mass compared with the amount expected in a child of the same height or length, and may have been the result of either failure to gain weight or from actual weight loss.

Although dichotomuos classification is frequently used in the literatures, it should be noted that in multivariable analysis such classification may reduce the discriminatory power of covariates in predicting the nutritional status of children.[1] However, the use of Z–scores as a continuous scale may have disadvantages for two reasons. First, a continuous scale is prone to bias due to measurement errors. Second, it is difficult to interpret results of analysis using Z–scores, since there is no easy practical and clinical applications for the continuous scale. A common method used in epidemiology is to present a risk of having certain characteristics, such as the risk of having first–degree, second–degree, or third–degree growth faltering.

As an intermediate approach we will use a scale similar to Gomez's classification, namely ordinal scale, but use a different set of cutpoints. We consider Z-scores above -1 as a normal, below -1 to -2 Z–scores as first–degree faltering, < -2 to -3 as second degree–faltering, and < -3 as third–degree of faltering. So, the ordinal, generalized linear model will be used in the multivariable analysis to accommodate this ordinal–dependent variable. This method is described in chapter 3.

7.2 PREVALENCE OF GROWTH FALTERING

7.2.1 Distribution by Age

The age and sex distributions of the children are shown in Table 7.1 (*page 228*). The distribution of children with the anthropomorphic data is very similar to the distribution for the total sample, except children in the category 0-2 months.[2] Considering that 94.3 percent of the sample have anthropometric data with a similar age distribution to the total sample, there should be no concern about a bias due to

[1] Often one is concerned about the gray area in the dichotomy scale.

[2] For children under 35 days old, sometimes mothers rejected having their baby weighed even in their home.

Table 7.1: AGE AND SEX DISTRIBUTION OF PRESCHOOL–AGED AGE CHILDREN, A RESULT OF THE TIMOR CHILD SURVIVAL STUDY, INDONESIA, 1988

AGE Group (Months)	Number of Children							
	Surviving reported				Sampled on Anthropometric			
	Female	Male	Total	Pct	Female	Male	Total	Pct
0–2	117	111	228	4.8	95	80	175	3.9
3–5	136	131	267	5.7	132	125	257	5.8
6–11	249	249	498	10.6	233	237	470	10.6
12–23	485	499	984	20.8	465	475	940	21.1
24–35	457	469	926	19.6	433	447	880	19.8
36–47	476	460	936	19.8	453	433	886	19.9
48–59	437	448	885	18.7	420	426	846	19.0
0–59	2357	2367	4724	100.0	2231	2223	4454	100.0

sampling coverage of our nutritional status indicators.

Table 7.2 (*page 229*) shows the age distribution of children into categories of underweight, stunted only, wasted only, and wasted plus stunted. In general, children showed considerably more stunting than wasting (*56.7 percent versus 16.8 percent*). Almost 36 percent were underweight and 5.1 percent fell into the category of stunting plus wasting.

There is clear evidence that prevalence of growth faltering varies according to age. Figure 7.1(*page 230*) shows the mean of Z–scores of children at given ages and Figure 7.2(*page 230*) shows the proportion of children that fell below -2 Z–scores for weight–for–age, height–for–age, and weight–for–height.

Gomez's classification criteria were applied, and the result is presented in Table 7.3 (*page 229*). "Severe malnutrition" or marasmus is defined by Welcome criteria (*WHO, 1971*) for children with weight below 60 percent of the median weight–for–age. Prevalence of marasmus is found to be 5.3 percent in this sample. The percent also increasing with the increase in age.

Table 7.2: PREVALENCE (PERCENT) OF GROWTH FALTERING BY AGE GROUP IN PRESCHOOL–AGED CHILDREN FROM THE TIMOR CHILD SURVIVAL STUDY, INDONESIA, 1988

AGE OF CHILDREN (Months)	GROWTH FALTERING CATEGORY			
	Under Weight	Stunted only	Wasted only	Stunted and Wasted
0–2	6.9	5.7	16.6	.0
3–5	14.0	21.0	9.3	.4
6–11	19.6	37.2	16.2	1.5
12–23	41.0	60.1	23.4	7.6
24–35	36.7	61.1	15.0	4.1
36–47	40.6	66.5	15.1	5.5
48–59	45.2	70.3	16.0	7.5
0–59	35.7	56.7	16.8	5.1

Table 7.3: PERCENTAGE DISTRIBUTION OF CHILDREN BY GOMEZ's CATEGORIES (WEIGHT–FOR–AGE) AND AGE GROUP, A RESULT OF THE TIMOR CHILD SURVIVAL STUDY, INDONESIA, 1988

AGE (Months)	Gomez's Category†				Total Percent	Total Children
	$> 90\%$	$75 - 90\%$	$60 - 74\%$	$< 60\%$		
0–2	73.7	19.4	6.3	0.6	100.0	(175)
3–5	61.9	24.1	12.4	1.6	100.0	(257)
6–11	32.1	48.3	15.8	3.8	100.0	(470)
12–23	15.0	44.0	35.9	5.1	100.0	(940)
24–35	14.7	48.6	31.8	4.9	100.0	(880)
36–47	6.7	52.7	33.8	6.8	100.0	(886)
48–59	5.8	49.0	38.1	7.1	100.0	(846)
0–59	18.3	46.0	30.4	5.3	100.0	(4454)

† Categories represent percentage of median weight–for–age

Figure 7.1: MEAN OF Z–SCORES OF TIMOR CHILDREN BY AGE IN MONTHS

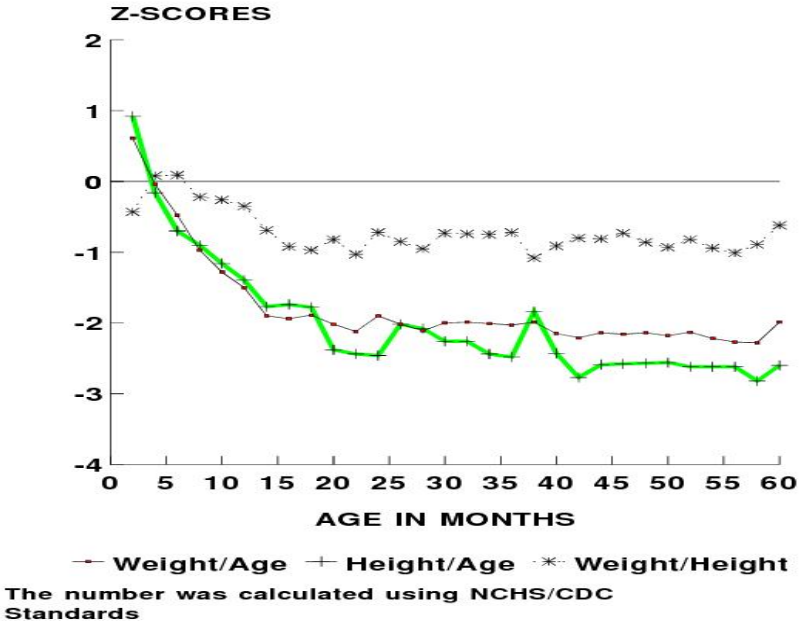


Figure 7.2: PERCENTS OF CHILDREN FALL BELOW -2 Z-SCORES BY AGE IN MONTHS

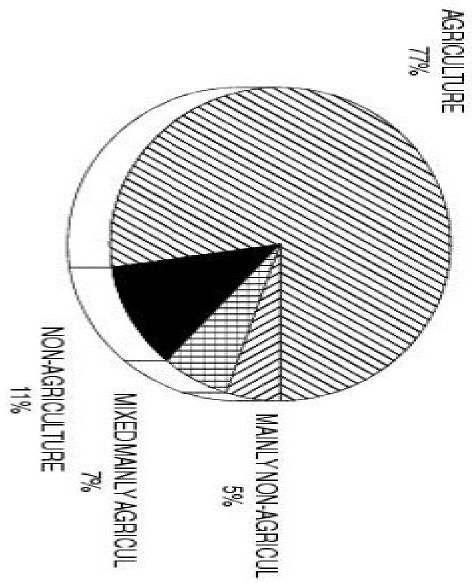


Table 7.4: PERCENTAGE DISTRIBUTION OF CHILDREN BY Z–SCORE CATEGORIES OF WEIGHT–FOR–AGE AND AGE GROUP, FROM TIMOR CHILD SURVIVAL STUDY, INDONESIA, 1988

AGE	Z–Scores Category†				Total	Total
Months	> -1	-1 *to* -2	-2 *to* -3	< -3	Percent	Children
0–2	82.9	15.4	1.7	0.0	100.0	(175)
3–5	69.7	21.8	7.0	1.6	100.0	(257)
6–11	35.3	35.5	21.7	7.5	100.0	(470)
12–23	16.7	26.5	36.8	20.0	100.0	(940)
24–35	15.3	33.3	33.4	18.0	100.0	(880)
36–47	7.8	36.8	36.2	16.4	100.0	(886)
48–59	6.5	33.6	42.0	18.0	100.0	(846)
0–59	20.3	31.5	32.9	15.3	100.0	(4454)

† Categories represent Z–Scores categories of weight–for–age

Many studies used the percentage of median weight–for–age and the percentage of weight–for–height with different cutpoints of classification. Our ordinal–scale classification is presented in Tables 7.4, 7.5, and 7.6 is based on the cutpoints of Z–scores as discussed in the previous section.

Table 7.4 shows the distribution of normal–weight children close to Gomez's classification (*Table 7.3*). But the distribution of the degrees of malnutrition are different, especially among those with third–degree growth faltering. Our Z–score classification shows more than twice higher than Gomez's classification after the age of 6 months. So using a Z–score classification will require a smaller sample size than what Gomez's criteria requires, if one estimates the prevalence of third–degree of growth faltering considers the same precisions.

The stunting distribution Table 7.5 (*page 232*) shows about one–third of the population under the category of third–degree faltering. After age 12 months the prevalence of stunting doubles and continues to increase slowly from that age category. It is not comparable with wasting in Table 7.6 (*page 233*), where the prevalence of third–degree

Table 7.5: PERCENTAGE DISTRIBUTION OF CHILDREN BY Z–SCORE CATEGORIES OF HEIGHT–FOR–AGE AND AGE GROUP, FROM TIMOR CHILD SURVIVAL STUDY, INDONESIA, 1988

AGE (Months)	Z–Scores Category†				Total Percent	Total Children
	> -1	-1 *to* -2	-2 *to* -3	< -3		
0–2	78.3	16.0	4.0	1.7	100.0	(175)
3–5	58.4	20.6	10.9	10.1	100.0	(257)
6–11	39.4	23.6	18.9	18.1	100.0	(470)
12–23	24.5	15.3	23.5	36.6	100.0	(939)
24–35	21.4	17.4	22.5	38.7	100.0	(879)
36–47	15.7	17.7	26.7	39.9	100.0	(885)
48–59	11.0	18.7	29.2	41.1	100.0	(846)
0–59	25.2	18.1	23.0	33.7	100.0	(4451)

† Categories represent Z–Scores categories of height–for–age

wasting is higher at ages 0-2 months and at ages 12-24 months. This may suggest that the prevalence of growth faltering is associated with weaning and its vulnerability to diseases. Compared to underweight and stunting, prevalence of wasting has less variation according to age.

The data shows that malnutrition in children varies with age. Figure 7.1(*page 230*) and Figure 7.2(*page 230*) show age trends of underweight, stunting, and wasting in our sample. There are significant increases in the prevalence of stunting and wasting after age 6 months with the peak for wasting at age 12-23 months. This age group may suffer the most from wasting due to the effects of weaning, which usually occurs in this age group. It may also be possible that infectious diseases (*i.e., measles*) caused this peak.

Figure 7.3(*page 234*) shows the distribution of weight–for–age Z–scores (*standard deviation*) along with the distribution of the NCHS/CDC data presented for comparison as suggested by WHO Working Group (*1986*). This figure also shows the distribution of height–for–age and weight–for–height in Z–scores. The distributions here are clearly show-

Table 7.6: PERCENTAGE DISTRIBUTION OF PRESCHOOL CHILDREN BY Z–SCORES CATEGORIES ACCORDING TO WEIGHT–FOR–HEIGHT AND AGE GROUP, A RESULT OF THE TIMOR CHILD SURVIVAL STUDY, INDONESIA, 1988

AGE	Z–Scores Category†				Total	Total
Months	> -1	$-1\ to\ -2$	$-2\ to\ -3$	< -3	Percent	Children
0–2	65.1	18.3	9.7	6.9	100.0	(175)
3–5	77.4	13.2	4.3	5.1	100.0	(257)
6–11	60.4	23.4	10.4	5.7	100.0	(470)
12–23	51.5	25.1	13.7	9.9	100.0	(940)
24–35	58.4	26.7	9.4	5.6	100.0	(877)
36–47	54.8	30.1	9.8	5.3	100.0	(885)
48–59	55.4	28.6	11.7	4.3	100.0	(846)
0–59	57.2	25.9	10.7	6.2	100.0	(4450)

† Categories represent Z–Scores categories of weight–for–height

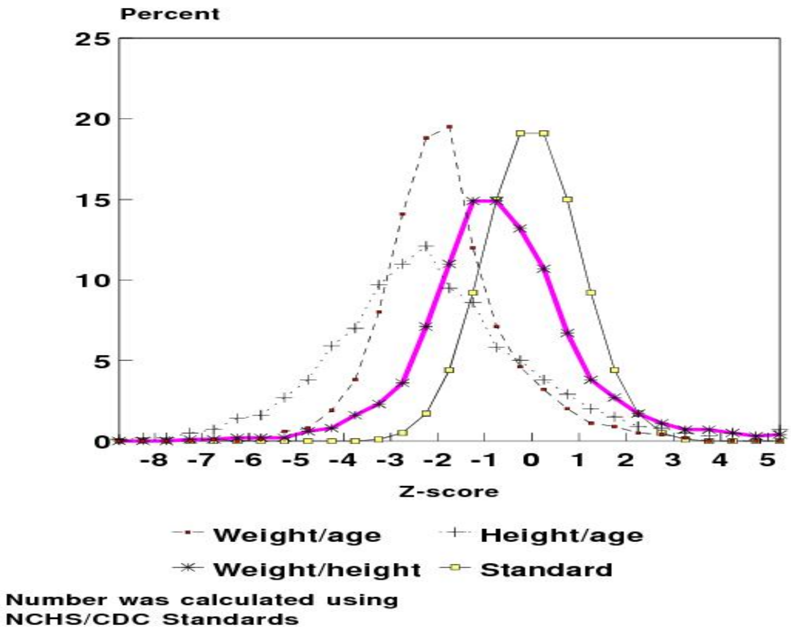
ing the high level of malnutrition that occurs in the population. Our data are displaced to lower values relative to the NCHS/CDC reference data, with the trend of stunting greater than wasting, as shown in Table 7.2 (*page 229*).

7.2.2 Variation According to Place and Region

In the aggregate analyses, we defined the level of growth faltering based a single indicator of growth faltering, using either weight–for–age, height–for–age, or weight–for–height. All children under–5 who fall below a -2 Z–score are considered to be in the category of growth faltering. From this definition, we calculate "a point prevalence rate" based on the proportion of children falling below the -2 Z–score.

There is a variation in these prevalence of growth faltering between urban and rural areas. The rural area has a higher prevalence of malnutrition than the urban, except for weight–for–height (*wasting*), which shows a prevalence rate higher in urban than rural. Figure 7.5(*page 235*) shows the differences between prevalence of growth

Figure 7.3: Distribution Curves of Weight–for–Age, Height–for–Age, and Weight–for–Height in Relation to Reference Z-scores



faltering in urban and rural areas. The following section will examine the determinants of prevalence of growth faltering at PHC level.

Figure 7.6(*page 236*) shows variation of prevalence rates of growth faltering according to weight–for–age, height–for–age, and weight–for–height at the district level. Among these prevalence rates, the numbers derived from height–for–age show less variation compared with numbers for weight–for–age and weight–for–height. However, using PHC as the unit of analysis, variation of prevalence according to PHC is very significant.

We can see prevalence of underweight, stunting, and wasting in Figure 7.6(*page 236*), Figure 7.7(*page 236*), and Figure 7.8(*page 236*) respectively. [3] However, caution must be given in interpreting this

[3]Prevalence of malnutrition in this area is considered high, so that sample size allows a stratified prevalence according to PHC-CA. In this study area, with an average

Figure 7.4: Prevalence Malnutrition by District

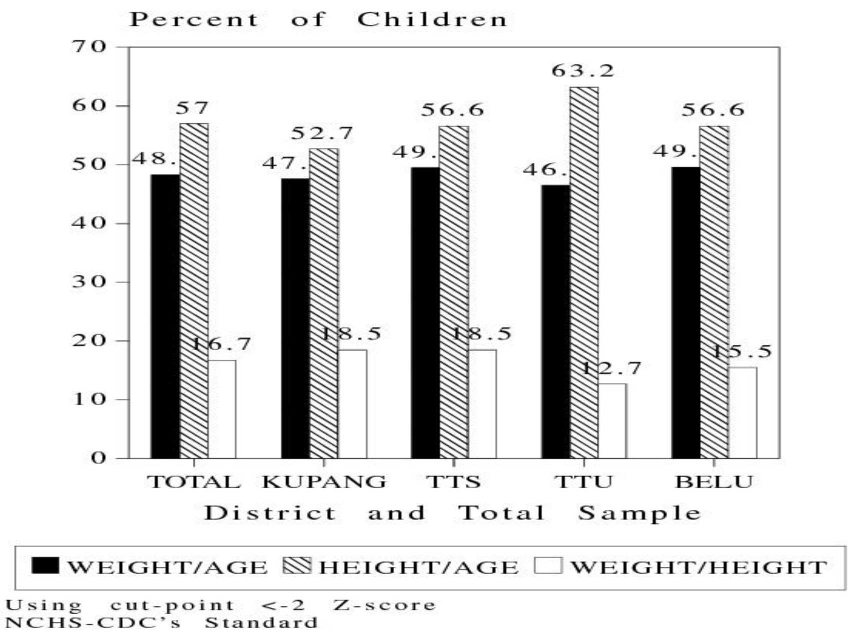


Figure 7.5: Prevalence Malnutrition by Residence

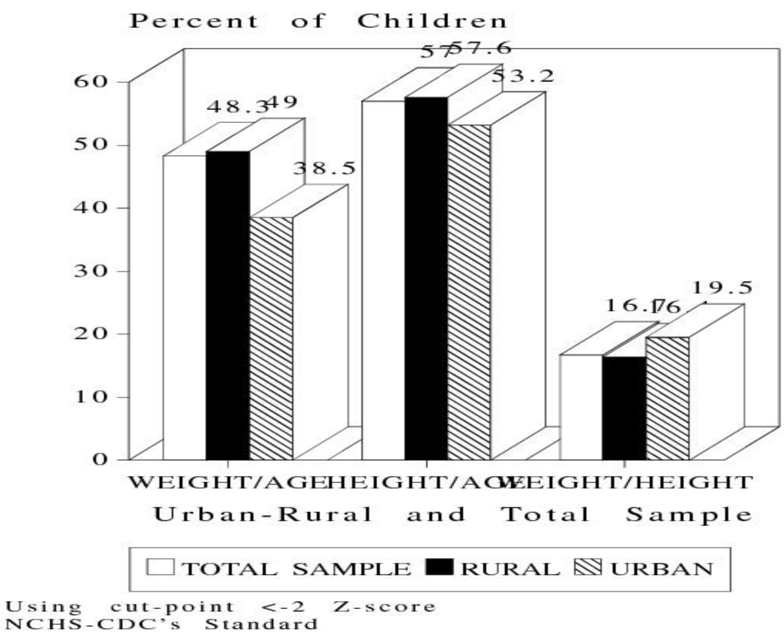


Figure 7.6: Prevalence of Underweight by PHC

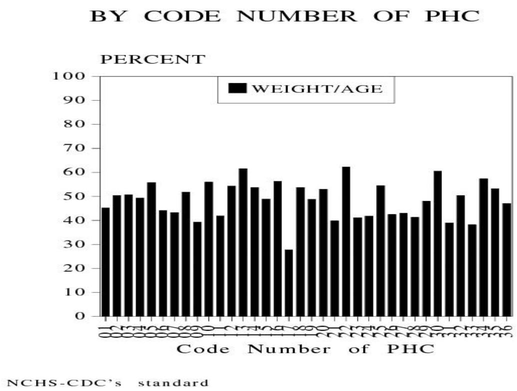


Figure 7.7: Prevalence of Stunting by PHC

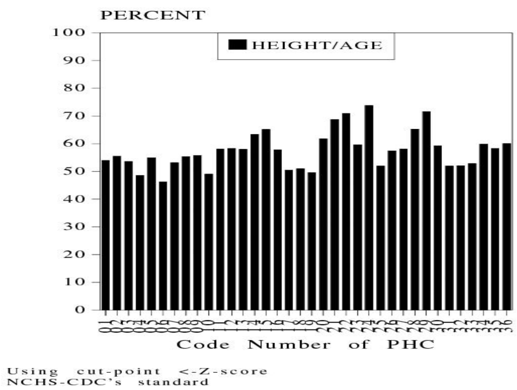
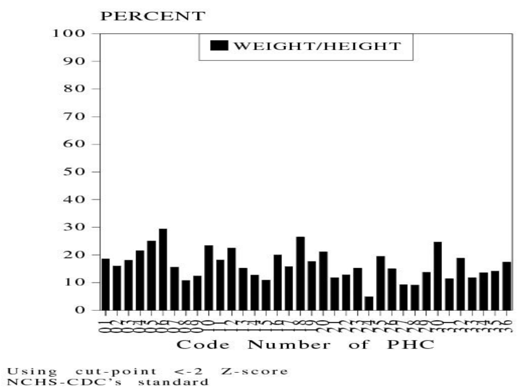


Figure 7.8: Prevalence of Wasting by PHC



data, due to small sample size problem.

7.3 ANALYSIS AT AGGREGATE LEVEL

We considered some PHC-CA characteristics that may be associated with the prevalence of growth faltering. These are: 1) level of child survival interventions, 2) health inputs, 3) social setting, and 4) regional development indicators. The simple correlation between these four factors and prevalence of growth faltering may be useful in detecting the net impact of child survival intervention at the aggregate level. Because limitations exist in an aggregate analysis, this analysis should be regarded as tentative in explaining the impact of child survival interventions. However, if there is a strong link between child survival interventions and nutritional impacts (*prevalence of growth faltering*), a simple association should render similar conclusions to the multivariable analysis. Therefore, findings in this section should be reconfirmed by multivariable analysis.

7.3.1 Level of Interventions and Growth Faltering

In assessing the impact of an particular form of intervention one may consider its outcome as an indicator of the strength (*level*) of intervention. For example, the proportion of children that had participated in UPGK, had Oralit, whose mothers ever had ANC or ever used contraception, and that had been immunized (fully or even partially) are used to indicate the strength of child survival intervention at PHC level. Table 7.7 (*page 238*) shows a correlation between level of intervention and prevalence of growth faltering at the PHC level.

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sample size of 120 children per PHC, one may obtain an acceptable point of estimate between 0.34 to 0.65.

Table 7.7: SIMPLE CORRELATION COEFFICIENT AND P VALUE† BETWEEN PREVALENCES OF GROWTH FALTERING AT THE PHC LEVEL AND SOME CHARACTERISTICS OF PHC

PUSKESMAS Characteristics	Proportion of growth faltering according to‡		
	Weight-for-age	Height-for-age	Weight-for-Height
INTERVENTIONS			
% Children had KMS (*UPGK*)	–.41 (.012)	.06 (.749)	–.32 (.060)
% Household had ORT	–.36 (.030)	–.46 (.005)	–.12 (.642)
% MWRA ever used FP method	–.53 (.000)	.37 (.024)	–.51 (.002)
% Women ever had ANC	–.58 (.001)	–.08 (.630)	–.11 (.520)
% Children ever immunized	–.51 (.001)	–.18 (.291)	–.08 (.631)
HEALTH INPUTS			
No. health workers per 100,000 pop.	–.08 (.644)	.34 (.044)	–.44 (.007)
No. staff medics per 100,000 pop.	–.30 (.075)	.34 (.040)	–.50 (.002)
No. of patients visited last year	–.37 (.024)	.21 (.216)	–.31 (.062)
SOCIAL SETTING			
Mean of MWRA's education	–.50 (.002)	–.21 (.214)	–.15 (.386)
Mean Father's education	–.54 (.001)	–.32 (.059)	–.00 (.991)
% Women ever heard immunization	–.56 (.000)	–.27 (.112)	–.14 (.405)
% Member of soc. organization	–.47 (.004)	–.01 (.951)	.30 (.073)
REGIONAL DEVEL-. OPMENT–INCOME			
% Village with asphalt road	–.50 (.002)	–.31 (.065)	.20 (.244)
% MWRA with septic latrine	–.38 (.022)	–.29 (.085)	.11 (.504)
Mean cash expend. in Rp.	–.36 (.034)	–.29 (.085)	.11 (.517)

† *Within Parentheses* ‡ *Notice: Prevalence is defined as below* -2 *Z–Scores of NCHS/CDC standard.*

All interventions have negative correlation with prevalence of growth faltering, which is measured according to weight–for–age of children under–5. Thus increasing percentage of under–5 children who received interventions would likely decrease the prevalence rate for growth faltering according to weight–for–age. Only variables on the percentage of households with ORT and MWRA as contraceptive users have negative correlations with "stunting" (*height–for–age*). Prevalence of "wasting" (*weight–for–height*) is correlated with percent of MWRA ever use contraception and percent of MWRA ever had ANC.

Three important results can be concluded from this table. First, except for the percentage of households had ORT, prevalence of stunting does not seem to have an association with the strength of child survival interventions. Also, there is a positive correlation between the prevalence of stunting and percent of MWRA ever used contraception. Thus, a PHC with more contraceptive users is likely to have a greater number of stunted children, but it will have fewer "underweight" and " wasting" children. Second, child survival interventions can be linked with underweight indicators. Third, an increasing of percentage of MWRA who had ever used contraception reduces the prevalence of wasting. Notice that an increasing of percentage of children who had ever participated in UPGK reduces the prevalence of wasting, but the coefficient of correlation is low (*.32*) and statistically significant at P=0.06.

7.3.2 Health Inputs and Growth Faltering

The number of government medical professionals (*medical doctors, paramedics, and nurses*) at PHC per 100,000 population is a proxy for health inputs. To reach rural households, PHC also trained volunteers as a village health workers (*Kader Sehat*). These volunteers are mainly involved in the POSYANDU activity, but *Kader Sehat's* activities vary from providing a simple treatment to promoting better health practices. Thus the number of village health workers trained per 100,000 population can be used a proxy for health inputs. It is reasonable to use the number of patients served per year as a proxy for how many health resources were used by PHC per year. These three variables may be associated with the prevalence of growth faltering.

All three variables have a positive correlation with the prevalence of stunting, though number of patients served per 100,000 population was not statistically significant. Thus, health input variables are associated with an increase of prevalence of stunting. All signs of correlation coefficients between proxies of health inputs and prevalence of underweight or wasting are negative. But the correlation between number of village health workers per 100,000 population and prevalence of underweight children is not statistically different from zero. Among these three proxies of health input, number of staff medics has the strongest association with all indicators of growth faltering. So increasing both child survival interventions and health inputs may increase prevalence of stunting, but it decreases the prevalence of underweight children under age 5.

7.3.3 Social Settings, Regional Developments and Growth Faltering

Mean of MWRA's education at the aggregate level has a strong correlation with prevalence of underweight, but shows no correlation with prevalence of stunting and wasting. Mean of father's education, percentage of MWRA ever heard the word immunization, and percentage of MWRA as members of a social organization have a similar pattern of associations as the mean of women's education. These findings suggest that social setting is strongly correlated with weight, but it does not strongly correlate with stunting and wasting.

Among the three indicators of prevalence of growth faltering, only prevalence of underweight can be linked to regional developments and income. Consider that percent of villages within PHC with asphalt roads and percentage of MWRA with access to a latrine facility are proxies for regional development. These two variables have negative correlations with the prevalence of underweight children under 5. But correlation coefficients between these two variables with either prevalence of stunting or wasting are very low, and most of them are statistically not different from zero. Mean of household cash expenditures at the PHC level, which acts as a proxy for level of income at PHC, shows moderate correlation with underweight but no correlation with stunting and wasting. One may conclude that prevalence of underweight may be good a indicator for the socioeconomic and regional development level at the aggregate level.

7.3.4 Links Between Macro Variables

So far our aggregate analysis uses a framework that assumes a direct association between an explanatory variable and outcomes. In reality, however, these health and socioeconomic variables are strongly correlated with each other. Indeed, the basic premise of our analysis is built on the fact that socioeconomic factors affect child survival through a number of proximate determinants, especially child survival interventions. Table 7.8 (*page 242*) shows that there are many positive correlations between proxies of child survival interventions and health

Table 7.8: CORRELATION COEFFICIENT AND THEIR P VALUE† BETWEEN PROPORTIONS OF UTILIZATION OF CHILD SURVIVAL INTERVENTIONS AND SOME PHC CHARACTERISTICS

PUSKESMAS Characteristics	PROPORTION OF USERS OF INTERVENTION				
	UPGK	ORALIT	Fam. Plann.	ANC	Immun.
HEALTH INPUTS					
No. health workers per 100,000 pop.	.16 (.347)	–.13 (.453)	.21 (.216)	.03 (.881)	–.08 (.661)
No. staff medis per 100,000 pop.	.21 (.215)	.08 (.655)	.32 (.053)	.19 (.264)	.05 (.762)
No. of patients visited last year	.48 (.003)	.32 (.056)	.44 (.007)	.28 (.094)	.38 (.020)
SOCIAL SETTING					
Mean of MWRA's education	.39 (.018)	.54 (.000)	.45 (.006)	.69 (.000)	.69 (.000)
Mean father's education	.32 (.054)	.58 (.000)	.38 (.022)	.64 (.000)	.71 (.000)
% Women ever heard immunization	.51 (.001)	.45 (.006)	.56 (.000)	.70 (.000)	.81 (.000)
% Member of social organization	.40 (.014)	.49 (.000)	.45 (.005)	.47 (.000)	.81 (.000)
REGIONAL DEVELOPMENT—INCOME					
% Village with asphalt road	.09 (.591)	.38 (.022)	.39 (.019)	.66 (.000)	.58 (.000)
% Women had septic latrine	.16 (.346)	.47 (.004)	.30 (.080)	.63 (.000)	.66 (.000)
Mean cash expendit. in Rp.	.07 (.687)	.54 (.001)	.18 (.284)	.52 (.001)	.50 (.001)

†*Within parentheses*

inputs, social setting, and regional developments.[4]

Table 7.8 suggests that social setting is a very important factor in the utilization of child survival intervention at the aggregate level. There is no association between the number of health providers and UPGK, Oralit, family planning, ANC, or immunization utilization. No-

[4]Because of correlations among these explanatory variables and the unit of analysis is only 36 PHC, we do not pursue aggregate analysis in multivariable fashions. We are also aware that aggregate analysis should be dealt with by a specific approach to reduce problems of ecological fallacies, as well as problems in handing proportion as an outcome analysis.

tice that most child survival interventions show a strong correlation with social–setting and regional development variables, but none is seen with health inputs. Thus at the aggregate level, the utilization of child survival interventions may be strongly conditioned by socioeconomic level. This suggests that the social- setting variable acts as a confounder on the utilization of child survival intervention. One interpretation is that the utilization is strongly affected by client demand.

In Indonesia, the distribution of child survival interventions is integrated between health and family planning programs. Furthermore, the role of community in the distribution of intervention is built into the program through POSYANDU. Table 7.9 (*page 244*) suggests that only the distribution of Oralit does not correlate with any other program; UPGK, family planning, ANC, and immunization correlate with each other. In particular, there are strong correlations between the utilization of immunization with ANC and family planning programs, but UPGK shows weaker correlations with ANC and family planning programs. One has to recognize that UPGK is community–based program, which has wider coverage and utilization than ANC and family planning programs.

The aggregate level analyses are subject to bias, when the aim of study is to examine risks at individual level. Yet, often such analyses are aimed to examine patterns of associations, which can be explained by a more refined analysis. We will analyze our data based on this finding using individual level observations.

7.4 RISKS OF GROWTH FALTERING

In this section, we defined growth faltering in a dichotomous scale, as used in the aggregate analysis. Here cutpoint is -2 Z-score for all mea-

Table 7.9: MATRIX OF CORRELATION COEFFICIENTS AND P VALUES† BETWEEN PROPORTIONS OF UTILIZATION OF CHILD SURVIVAL INTERVENTIONS

PUSKESMAS	PROPORTION OF USERS OF INTERVENTIONS				
Characteristics	UPGK	ORALIT	Fam. Plann.	ANC	Immun.
UPGK	1.00 —	.24 (.160)	.38 (.023)	.34 (.040)	.51 (.001)
ORALIT	.24 (.160)	1.00 —	.07 (.078)	.26 (.133)	.045 (.006)
Fam. Planning	.38 (.023)	.07 (.078)	1.00 —	.64 (.000)	.56 (.000)
ANC	.34 (.040)	.26 (.133)	.64 (.000)	1.00 —	.70 (.000)
Immunization	.51 (.001)	.45 (.006)	.56 (.000)	.70 (.000)	1.00 —

†*Within parentheses*

sures: weight–for–age, height–for–age, and weight–for–height. Because our assessment will be based on the estimates of relative risks, we rearrange the reference category such that the best that can be expected is used as a reference group. For example, since the children with mothers who have secondary schooling or above are hypothesized to have a lower risk of growth faltering, they would be used as a reference category for children whose mother belongs to one of the categories primary school completed, some primary school, and no formal education.

To obtain a parsimonious model, the first step is an examination of a simple association between factors included in our analytical framework using estimates of relative risks. Considering that the prevalence of growth faltering depends on child's age and sex, the estimates of relative risks will be adjusted for age and sex of children, using a logistic regression technique (*Hosmer and Lemeshow, 1989*). Namely, the estimated relative risks (*RR*) were calculated by taking an exponential of parameter estimates of interventions under model that includes age and sex as explanatory variables in the logistic regression equation.

Table 7.10 (*page 246*) shows the estimates of odds ratio (*OR*) and 95 percent confidence intervals for each factor associated with the category underweight, stunting, and wasting. If the values of the 95 percent confidence interval of relative risks includes unity, we consider that variable is not a statistically significant determinant. Unless conceptually important and no other variable can be used as an alternate measure, we will drop such factors from a multivariable analysis. So these relative risks could be viewed in conjunction with a multivariable analysis for variable reduction.

7.4.1 Proximate Determinants and Nutritional–Status

The number of proximate determinants selected in this analysis is similar to the survival analysis in the previous chapter. This is because of our intention to compare models associated with growth faltering and child mortality.

Table 7.10 shows factors that can be associated with maternal, nutritional, environmental, and personal preventive/illness controls. For example, lower crowding index, availability of soap, latrine facilities, piped water, concrete wall or floor are used as proxies for environmental factors. Of course we hypothesize that these factors are more favorable (*RR=1*) than other categories, so these will be used as the reference categories. However, one may argue that some of these factors(*e.g., latrine facilities*) should be treated as a proxy for socioeconomic factors.

Parity, age of mother, and ever used contraceptives are assumed proxies for maternal factor. While other factors such as immuniza-

Table 7.10: ODDS RATIOS AND 95 PERCENT OF CONFIDENCE INTERVALS† FOR CHILDREN FALL BELOW –2 Z–SCORES OF WEIGHT–FOR–AGE, HEIGHT–FOR AGE, AND WEIGHT–FOR–HEIGHT ON PROXIMATE DETERMINANT VARIABLES ‡

Variables	Weight-for-Age		Height-for-Age		Weight-for-Height	
	OR	95%–CI	OR	95%–CI	OR	95%–CI
IMMUNIZATION STATUS						
Not complete	0.9	0.7–1.1	1.1	0.9–1.3	0.9	0.7–1.2
Never immunized	1.0	0.8–1.2	1.1	0.9–1.3	1.1	0.8–1.4
BCG SCAR						
Negative	1.1	1.0–1.3	1.1	0.9–1.2	1.0	0.9–1.2
RECEIVED TT						
None	1.1	1.0–1.3	1.1	1.0–1.3	1.0	0.9–1.2
BIRTH ATTENDANT						
Tba	1.7	1.3–2.0	1.4	1.1–1.7	1.3	1.0–1.7
Family	1.7	1.4–2.1	1.3	1.1–1.6	1.3	1.0–1.6
DELIVERY PLACE						
Home	1.7	1.3–2.1	1.4	1.1–1.8	1.2	0.9–1.7
STILL BREASTFEEDING						
No	0.8	0.7–1.0	0.8	0.7–1.0	0.9	0.7–1.1
PROMOTED BREASTFEED						
No	1.2	1.1–1.4	1.0	0.9–1.1	1.4	1.2–1.7
SICK WITHIN 2 WKS						
Yes	1.5	1.3–1.8	1.5	1.3–1.8	1.3	1.1–1.5
FREQUENT SICK						
Yes	1.4	1.1–1.6	1.2	1.0–1.5	1.0	0.8–1.2
EVER WEIGHT						
No	0.8	0.7–0.9	0.9	0.8–1.2	1.0	0.8–1.2
HOUSEHOLDS KEPT KMS						
No	0.9	0.8–1.0	1.1	1.0–1.2	1.2	1.1–1.4
MODERN DRUGS AVAILABLE						
No	1.0	0.9–1.2	1.2	1.0–1.4	1.2	0.9–1.5
ANC FOR THIS CHILD						
No	1.2	1.1–1.4	1.0	0.9–1.2	1.1	1.0–1.3
CONTRACEPTIVE USE						
Never used	1.2	1.1–1.3	0.9	0.8–1.0	1.2	1.1–1.4
PARITY OF MOTHER						
4 and More	1.1	0.9–1.2	0.9	0.8–1.1	1.0	0.9–1.2
AGE OF MOTHER						
25–35 Years	0.8	0.7–1.0	1.0	0.9–1.2	0.8	0.6–1.0
Above Years	1.0	0.8–1.2	1.4	1.1–1.7	0.7	0.6–1.0
MAIN FLOOR MATERIALS						
Non–concrete	1.4	1.2–1.6	1.2	0.9–1.3	0.8	0.7–1.0
MAIN WALL MATERIALS						
Non–concrete	1.1	1.0–1.3	1.1	1.0–1.3	0.9	0.7–1.0
DRINKING WATER						
Non pipe	1.5	1.3–1.7	1.1	1.0–1.3	1.1	0.9–1.3
WATER FOR WASHING						
Non pipe	1.4	1.3–1.6	1.1	1.0–1.3	1.1	0.9–1.3
LATRINE FACILITIES						
Pit latrine	1.6	1.2–2.1	1.7	1.4–2.2	0.9	0.6–1.2
River/garden	1.5	1.2–2.1	1.6	1.2–2.1	1.0	0.7–1.4
AVAILABILITY OF SOAP						
No	1.3	1.1–1.5	1.1	1.0–1.2	1.0	0.9–1.3
CROWDING INDEX						
Below Median	1.2	1.0–1.4	1.0	0.8–1.2	1.2	1.0–1.5

†Adjusted for Age and Sex ‡These odds ratios are sex and age adjusted. The numbers are calculated based on the coefficient estimates of logistics regression.

tion status (*including BCG scar positive*), received TT, birth attendant present, place of delivery, ever been advised to continue breast-feeding at least 6 months, antenatal care for a child, brought a child to weighing program, and kept growth card and modern drugs at home are used as a proxies for curative and preventive illness controls. Only breast–feeding is used as a proxy for nutrient adequacy. Because age and sex are usually factors strongly associated with growth faltering, Table 7.10 (page 246) has been constructed based on the logistic regression coefficient, which is always adjusted for age and sex in the model. It should be stressed here that most of these factors can be directly associated with the GOBI intervention.

Among the many factors considered, birth attendant, place of delivery, ever had antenatal care (*ANC*), ever used any modern contraceptive method, main floor materials, sources of drinking water and washing, latrine facilities, and availability of soap are significantly associated with underweight. However, only birth attendant and place of delivery are associated with stunting. The use of a modern contraceptive method and availability of a growth card can be associated with wasting, while birth attendant and place of delivery lack significance due to too wide a confidence interval.

Interpretation of this association has to be done carefully. For example, children whose delivery was helped by a birth attendant are at 1.7 times higher risk of becoming underweight, or 1.4 times higher for stunting, and 1.3 times higher for wasting compared to children whose mother was helped by medical professionals. A similar pattern is found for deliveries helped by family alone. However, these two variables may not be a direct proxy for growth faltering through birth process itself rather than through the utilization of other modern health services. So one may interpret that risk of growth faltering for children whose mothers had no access to modern medical services during birth is higher for those who utilized such modern services.

7.4.2 Socioeconomic Factors and Nutritional Status

In the previous chapter, we considered several socioeconomic and mother's characteristics as explanatory factors for the determinants of mortality. These factors are also considered in this chapter. Table 7.11 (page 249) Place of residence (*urban/rural*) and region of residence are suspected to be important factors in determining of prevalence of growth faltering. Urban children are expected to have a better nutritional status than rural children. Similarly, children from Kupang, which has more urban characteristics than does Belu, should a have lower risk of growth faltering than children from Belu.

In a previous mortality analysis, we considered father's education and occupation as potential risk factors. Similarly, main source of income (*agriculture and non-agriculture*), total household cash expenditures (*below or upper median population*), availability of modern amenities and electricity are considered as a proxy for income, wealth, or a social status level of the family. For mother's characteristics, her educational level and health knowledge (*measured as ever or never the heard word immunization*) are examined with other factors, such as place of work, religion, membership status in social organizations, and her attention to child weight. These variables are examined with underweight, stunting, and wasting as an individual outcome variables.

The results suggest that mother's education shows an important association with the underweight indicator while immunization knowledge and social organization membership indicate statistically a sig-

Table 7.11: ODDS RATIOS AND 95 PERCENT OF CONFIDENCE INTERVALS† FOR CHILDREN FALL BELOW –2 Z–SCORES OF WEIGHT–FOR–AGE, HEIGHT–FOR AGE, AND WEIGHT–FOR–HEIGHT ON SOCIOECONOMIC VARIABLES ‡

Variables	Weight-for-Age		Height-for-Age		Weight-for-Height	
	OR	95%–CI	OR	95%–CI	OR	95%–CI
MOTHER'S CHARACTERISTICS						
MOTHER'S EDUCATION*						
Primary Completed	1.6	1.3–1.9	1.3	1.1–1.6	1.1	0.9–1.5
Some Primary	1.6	1.3–2.0	1.3	1.0–1.6	1.1	0.8–1.4
None	1.8	1.5–2.2	1.2	1.0–1.4	1.5	1.2–2.0
PLACE OF WORK						
At Home	0.9	0.7–1.0	0.9	0.9–1.1	0.8	0.7–1.0
SOCIAL ORGANIZATION						
Non–member	1.2	1.1–1.4	1.1	0.9–1.2	1.2	1.0–1.4
WORD IMMUNIZATION						
Never heard	1.2	1.1–1.4	1.1	1.0–1.2	1.2	1.0–1.4
LAST WEIGHT HER CHILD						
Did not remember	1.2	1.0–1.4	1.1	0.9–1.3	1.2	1.0–1.5
WOMAN'S RELIGION						
Roman Catholic	1.0	0.9–1.2	1.2	1.0–1.3	0.8	0.7–0.9
FATHER'S EDUCATION						
Primary Completed	1.3	1.1–1.6	1.3	1.1–1.5	1.0	0.8–1.2
Some Primary	1.6	1.3–1.9	1.4	1.1–1.7	1.1	0.8–1.4
None	1.6	1.4–1.9	1.2	1.0–1.4	1.2	1.0–1.6
HUSBAND'S OCCUPATION						
Priv with employer	1.7	1.4–2.0	1.4	1.2–1.7	1.0	0.8–1.3
None/self employe	1.7	1.3–2.4	1.5	1.1–2.0	1.2	0.8–1.8
MODERN AMENITIES						
Not Available	1.2	1.1–1.4	1.1	1.0–1.3	1.1	0.9–1.2
ELECTRICITY						
Not Available	1.5	1.3–1.7	1.0	0.8–1.3	0.8	0.6–0.9
TOTAL CASH EXPENDITURE						
Below median pop	1.0	0.9–1.1	1.2	1.1–1.4	0.7	0.6–0.9
MAIN SOURCE OF INCOME						
Agriculture	1.5	1.3–1.8	1.4	1.2–1.7	0.9	0.7–1.1
PLACE OF RESIDENCE						
Rural	1.6	1.3–1.9	1.2	1.0–1.4	0.8	0.6–1.0
REGION OF RESIDENCE**						
District Kupang	0.9	0.7–1.1	0.8	0.7–1.0	1.3	1.0–1.6
District TTS	1.0	0.8–1.2	1.0	0.8–1.2	1.2	1.0–1.5
District TTU	0.8	0.7–1.0	1.4	1.1–1.7	0.8	0.6–1.1

†Adjusted for Age and Sex ‡These odds ratios are sex and age adjusted. The numbers are calculated based on the coefficient estimates of logistics regression.
*References categories are: * a secondary school or above and ** District of Belu.*

nificant association. But the relative risk of these two later factors is very low (*RR=1.2*). Place of work, knowledge about her child weight, and religion cannot be associated with underweight (*95 percent confidence interval includes unity*).

Place of residence, education and occupation of father, main source of income, and availability of electricity and modern amenities are significantly associated with underweight. But total cash expenditures (*below or upper median value*) and region of residence (*districts*) could not be associated with underweight. Children whose father had some primary education have a risk of underweight 1.6 times higher than children whose father had secondary education or more (*a reference category*). Similarly, children whose father fell into the category of primary school completed have a risk 1.3 times higher than the reference category. Children whose fathers was not working as a civil servant or in the army (*pegawai negeri or ABRI*) have a relative risk 1.7 while children with a father working in agriculture sector have 1.5 higher risk of underweight compared with those whose father works in nonagricultural sector. Children living within households not having electricity and not having modern amenities have relative risks of 1.5 and 1.2 respectively.

Factors associated with stunting are mother's education, education and occupation of the father, and main sources of household income. Other possible factors included are total cash expenditures, place of residence, and living in District TTU compared to Belu. Other factor such as mother's place of work, religion, immunization knowledge, and awareness about her child weight show no significant increase or decrease in the risk of stunting (*confidence interval includes unity*). Similarly, the availability of modern amenities and electricity within household did not show a significant association with stunting.

Factors associated with wasting are less clear, since only mother's education is statistically significant. Many factors suggest some risk, especially based on their upper confidence intervals. These factors are mother's membership in a social organization, knowledge on immunization or weight of her child, father's education, occupation, region of residence in Kupang and TTU. But they are not statistically significant, since the confidence interval includes unity. By looking at the empirical findings and the theoretical framework, we should reduce the number of variables included in the multivariable analysis. However, because our main interest lies in child survival intervention, all child survival intervention variables should be included in the multivariable analysis. We will explore further details in a multivariable analysis by considering an ordinal scale outcome as described in the previous section.

7.5 MULTIVARIABLE ANALYSIS

Following the conceptual framework discussed in chapter 3, we present the results of regressing nutritional status indicators on a set of child survival interventions. Nutritional status indicators are considered as ordinal dependent variables. Here all Z-scores of weight–for–age, height–for–age, and weight–for–height greater or above -1 are assigned as 0. A Z–score below -1 to -2 is assigned as 1, while -2 to -3 and below -3 are assigned as 2, and 3 respectively. Thus dependent variables are ordinal scales with range values between 0 to 3.

Because mother's age, birth order, and child's age are biologically important as determinants of child growth faltering, these variables are retained in the models to serve as comparisons for current models with previous mortality analyses. We considered the same intervention variables used in the survival analysis. These variables are UPGK, ORT, contraceptive use, TT at ANC, immunization, and breast–feeding status. Mother's education, father's occupation, and an access to latrine facility are also examined in the models. Macro variables on the proxies for health and family planning programs, availability of these services, and a regional development indicators are also considered in the following nutritional status models.

7.5.1 Determinants of Growth Faltering According to Weight–for–Age

Intervention Effects Adjusted for Biologic Factors

Table 7.12 (*page 253*) shows parameter estimates of intervention effects on nutritional status according to weight–for–age (*underweight*). These effects have been adjusted for child's and mother's ages and child birth order. Child's age is transformed into a natural logarithm scale. A quadratic term of birth order is also included in the model to capture a nonlinear effect of birth order. Equation 1 suggests that only the parameter estimate of child's age is a statistically difference from zero. The prevalence of underweight increases in an exponential manner as child grows older (*with increasing of child's age months*), which is consistent with findings in the previous descriptive analysis.

Equations 2 to 7 show parameter estimates of UPGK, ORT, immunization status, contraceptive use, TT at ANC, and breast–feeding status at the time of survey respetively. These parameter estimates have been adjusted for mother's and child's age, birth order, and a quadratic term of birth order. Equation 8 shows all intervention variables in the single model, which has also been adjusted for mother's

Table 7.12: PARAMETER ESTIMATES OF INTERVENTION EFFECTS ON WEIGHT–FOR–AGE ADJUSTED FOR BIOLOGICAL FACTORS† USING A PROPORTIONAL ODDS MODEL FOR ORDINAL DATA

VARIABLES	Eq.1	Eq.2	Eq.3	Eq.4	Eq.5	Eq.6	Eq.7	Eq.8
BIOLOGIC MOTHER'S:								
Age at birth	.003 (.345)	.003 (.344)	.003 (.337)	.003 (.303)	.003 (.341)	.003 (.336)	.003 (.303)	.003 (.291)
CHILD'S AGE								
In Log Month	–1.011 (.000)	–1.017 (.000)	–1.010 (.000)	–1.010 (.000)	–1.015 (.000)	–1.009 (.000)	–1.137 (.000)	–1.143 (.000)
CHILD'S								
Birth order	–.008 (.427)	–.008 (.423)	–.007 (.440)	–.012 (.397)	–.007 (.440)	–.007 (.439)	–.003 (.478)	–.003 (.478)
(Birth Order)^2	–.002 (.297)	–.002 (.300)	–.002 (.288)	–.002 (.325)	–.002 (.288)	–.002 (.292)	–.003 (.229)	–.003 (.237)
HEALTH INTERVENTIONS								
UPGK:								
Nonparticipant		–0.060 (.194)	—	—	—	—	—	–.145 (.135)
ORT								
No Oralit			–.176 (.086)	—	—	—	—	–.145 (.135)
IMMUNIZATION								
Not completed				–.033 (.340)	—	—	—	–.026 (.372)
FAM. PLANNING								
Never used					–.123 (.098)	—	—	–.006 (.273)
TT at ANC								
Never had TT						–.115 (.054)	—	–.080 (.149)
BREASTFEEDING								
Had stopped							.412 (.000)	.418 (.000)
LR Null Model	4356	4356	4356	4356	4356	4356	4356	4356
LR Model	3948	3948	3947	3948	3947	3947	3934	3931
AIC with $\beta = 0$	822.4	823.2	824.3	822.6	824.1	825.0	850.5	855.9
No.of cases	4452	4452	4452	4452	4452	4452	4452	4452

†Note: Three intercept parameters are not presented in the table. P values within parenthesis. The coefficients of each categorial variable represents contrast with categories deleted.

and child's ages, a birth order, a quadratic term of birth order, and breast–feeding status. Among these eight equations, only the parameter estimate of breast–feeding status is a statistically different from zero ($.412$). Although other parameter estimates are below zero (*negative sign*), but these estimates are not statistically different from zero.

The relative risk estimates (*RR*) of intervention variables can be derived from their parameter estimates. For example, the relative risk of nonusers contraception can be derived from an exponential of the minus of a parameter estimate,[5] so that $RR = \exp\left(-(-.123)\right) = 1.13$. Table 7.12 suggests that none of the intervention variables has a significant effect on child weight and even when taken together they are not significant (*equation 8*). It should be noted that the parameter estimate of breast–feeding status (*stopped breast–feeding*) is positive, which suggests that still breast–feeding may increase the probability a child fals into an underweight category.[6]

Intervention Effects At The Macro Levels and SES variables Adjusted for Biologic Factors

Table 7.13 (*page 255*) shows effects of health and family planning programs at the macro level (*equations 6 and 7*) and socioeconomic status at the micro level (*equations 1 to 5*) on weight–for–age.

The availability of health services and a proxy for regional development are also included in the table (*equation 8*). Parameters of estimates of health and family planning programs at the PHC level

[5] By the convention discussed in chapter 3, we have to reverse the sign of the parameter estimate, so $RR = \exp(-\Delta)$ where Δ is a parameter estimate.

[6] We did not pursue this issue in further detail. But if this finding is correct, longer breast–feeding may be associated with no food supplements given during a breast–feeding period. Mothers may assume that breastmilk alone would be adequate food for children, regardless of child's age. Since prevalence of growth faltering increases steadily after six months and breast–feeding continued longer than 6 months, this may explain such an unexpected result.

Table 7.13: PARAMETER ESTIMATES OF INTERVENTION EFFECTS AT THE MACRO LEVEL ON WEIGHT–FOR–AGE ADJUSTED FOR BIOLOGICAL FACTORS† USING A PROPORTIONAL ODDS MODEL FOR ORDINAL DATA

VARIABLES	Eq.1	Eq.2	Eq.3	Eq.4	Eq.5	Eq.6	Eq.7	Eq.8
BIOLOGIC MOTHER'S:								
Age at birth	.004 (.293)	.007 (.244)	.002 (.359)	.003 (.318)	.003 (.337)	.004 (.279)	.004 (.276)	.003 (.309)
CHILD'S AGE								
In Log Month	–1.009 (.000)	–1.012 (.000)	–1.012 (.000)	–1.014 (.000)	–1.011 (.000)	–1.011 (.000)	–1.016 (.000)	–1.011 (.000)
CHILD'S								
Birth order	–.003 (.476)	–.010 (.412)	–.008 (.431)	–.009 (.419)	–.009 (.420)	–.010 (.416)	–.012 (.394)	–.014 (.382)
(Birth Order)^2	– .003 (.273)	–.002 (.308)	–.002 (.291)	–.002 (.299)	–.002 (.292)	–.002 (.292)	–.002 (.330)	.003 (.330)
SES VARIABLES MOTHER'S								
Educt. <second.	–.329 (.000)	—	—	—	—	—	—	—
Never Heard immunization		–.259 (.000)	—	—	—	—	—	—
LATRINE								
No latrine			–.288 (.012)	—	—	—	—	—
FATHER'S OCC.								
Non Civil/Army				–.367 (.000)	—	—	—	—
EXPENDITURES								
Log in Rp.					.034 (.224)	—	—	—
MACRO VAR.								
Health Program						.546 (.013)	—	—
Family Planning							.857 (.000)	—
Regional Development								.048 (.058)
Availability Services								.155 (.065)
LR Null Model	4356	4356	4356	4356	4356	4356	4356	4356
LR Model	3942	3940	3945	3940	3948	3946	3943	3946
AIC with $\beta = 0$	834.4	838.7	827.5	838.7	823.0	827.3	832.9	826.5
No. of cases	4452	4452	4452	4452	4452	4452	4452	4452

†*Note: Three intercept parameters are not presented in the table. P values within parethesis. The coefficients of each categorial variable represent a contrast with deleted categories.*

are statistically significant and greater than zero. This suggests that an increase of family planning or health programs will decrease the prevalence of underweight children.[7] However, the availability of government health services and a proxy for regional development show no significant associations with the child weight–for–age.

Mother's education and knowledge on immunization show significant effects on weight, even after they have been adjusted for biological factors. Children whose mother's education is below secondary school are 1.4 times likely to have underweight status compared to children whose mother's education is secondary school or more. Although immunization status of children cannot be associated with underweight, children whose mothers have never heard the word immunization have a 1.3 times greater risk of being underweight compared with the reference category. This suggests that ever heard immunization may also be a proxy for health knowledge in general, rather than for child immunization only.

An availability of latrine facility and father's occupation is associated with underweight children. Children whose father's occupation are not–*pegawai negeri* or ABRI are more likely to be underweight. Children whose families have no flush latrine are more likely to be underweight. Father's occupation has an equal RR with the mother's education, while the availability of a flush latrine has RR similar in size to that for knowledge of immunization. Only income (*in a logarithm scale*) shows no significant effect on weight.

[7]We have to follow our previous convention, which is to reverse the sign of the parameter estimate.

Intervention Effects Adjusted for Biologic, The Micro and Macro Variables

Table 7.14 (*page 258–259*) shows intervention effects, which have been adjusted for the SES and other variables at the macro level. Adjusting for mother's education, availability of latrine, father's occupation, and income show no significant effects on the parameter estimates of intervention variables on weight–for–age (*compare parameter estimates across columns on each category*). It should be noted that the effect of the latrine variable is diminished by putting all SES variables in the single model. This suggests that availability of a latrine may be a proxy for SES instead of an environmental factor.

After SES and intervention variables at the micro level and health program are included in the single model, there is no independent effect of health program at the macro level (*compare equations 6 and 8*); indeed, the sign of the coefficient reverses from positive to negative. On the other hand, the family planning program still shows a strong effect, even it has been adjusted for the regional development in the model (*equations 8*).

From Tables 7.12, 7.13, and 7.14, we may conclude that the intervention effects at the micro level cannot be associated with the probability of children being underweight. However, data clearly suggest that a strong family planning program at the macro level may reduce the prevalence of underweight, but it does not operate through variable contraceptive use. One may notice that mother's education and father's occupation are strongly related to underweight. Reduction of the parameter estimates of SES variables from their previous models suggests that the effects of mother's education and father's occupation operate through other variables.

Table 7.14: PARAMETER ESTIMATES OF INTERVENTION EFFECTS ON WEIGHT–FOR–AGE ADJUSTED FOR BIOLOGICAL, SES, MACRO VARIABLES† USING A PROPORTIONAL ODDS MODEL FOR ORDINAL DATA

VARIABLES	Eq.1	Eq.2	Eq.3	Eq.4	Eq.5	Eq.6	Eq.7	Eq.8
BIOLOGIC MOTHER'S:								
Age at birth	.004 (.256)	.003 (.244)	.004 (.276)	.004 (.290)	.004 (.270)	.004 (.256)	.005 (.219)	.004 (.244)
CHILD'S AGE								
In Log Month	–1.138 (.000)	–1.142 (.000)	–1.142 (.000)	–1.143 (.000)	–1.140 (.000)	–1.140 (.000)	–1.150 (.000)	–1.152 (.000)
CHILD'S								
Birth order	–.000 (.498)	–.003 (.478)	–.005 (.456)	–.003 (.477)	–.001 (.488)	–.002 (.484)	–.002 (.479)	–.000 (.419)
(Birth Order)^2	– .003 (.229)	–.003 (.235)	–.003 (.247)	–.003 (.237)	–.003 (.254)	–.003 (.245)	–.003 (.254)	–.003 (.245)
HEALTH INTERVENTIONS								
UPGK:								
Nonparticipant	–.041 (.284)	–.050 (.247)	–.044 (.275)	–.050 (.246)	–.041 (.288)	–.038 (.302)	–.035 (.315)	–.034 (.320)
ORT								
No Oralit	–.103 (.218)	–.132 (.168)	–.097 (.230)	–.144 (.137)	–.085 (.261)	–.088 (.254)	–.105 (.215)	–.100 (.226)
IMMUNIZATION								
Not completed	–.030 (.413)	–.022 (.394)	–.026 (.374)	–.026 (.372)	–.027 (.368)	–.027 (.369)	–.004 (.478)	–.002 (.489)
FAM. PLANNING								
Never used	–.023 (.413)	–.044 (.335)	–.019 (.425)	–.061 (.275)	–.001 (.496)	–.088 (.254)	–.016 (.437)	–.060 (.273)
TT at ANC								
Never had TT	–.042 (.292)	–.061 (.213)	–.025 (.373)	–.079 (.154)	–.017 (.413)	–.011 (.447)	–.002 (.488)	–.009 (.456)
BREASTFEEDING								
Had stopped	.411 (.000)	.414 (.000)	.409 (.000)	.418 (.000)	.408 (.000)	.409 (.000)	.426 (.000)	.430 (.000)
Continued on next page								

Table 7.14: CONTINUED

VARIABLES	Eq.1	Eq.2	Eq.3	Eq.4	Eq.5	Eq.6	Eq.7	Eq.8
SES VARIABLES:								
MOTHER'S								
Educt. <second.	–.278 (.003)	—	—	—	–.178 (.054)	–.172 (.061)	–.156 (.080)	–.175 (.058)
LATRINE								
No latrine		–.212 (.054)	—	—	–.083 (.277)	–.081 (.280)	–.089 (.261)	–.108 (.222)
FATHER'S OCC.								
Non Civil/Army			–.324 (.000)	—	–.278 (.005)	–.263 (.009)	–.242 (.013)	–.284 (.006)
EXPENDITURES								
Log in Rp.				.003 (.477)	–.059 (.113)	–.061 (.105)	–.057 (.123)	–.041 (.206)
MACRO VAR.								
Health Program						.159 (.287)	—	–.156 (.330)
Family Planning							.774 (.002)	.994 (.001)
Regional Development								.175 (.092)
LR Null Model	4356	4356	4356	4356	4356	4356	4356	4356
LR Model	3927	3930	3926	3931	3923	3923	3920	3918
AIC with $\beta = 0$	863.6	858.5	867.2	855.9	871.4	871.7	879.2	882.0
No. of cases	4452	4452	4452	4452	4452	4452	4452	4452

†*Note: Three intercept parameters are not presented in the table. P values within parenthesis. The coefficients of each categorial variable represent a contrast with deleted categories*

7.5.2 Determinants of Growth Faltering According to Height–for–Age

Intervention Effects Adjusted for Biologic Factors

Following the previous analysis, Table 7.15 (*page 261*) shows the effects of intervention variables on the nutritional status indicator according to height–for–age (*stunting*). These effects have also been adjusted for biologic factors. Similar to findings in Table 7.12 (*page 253*), at the micro level none of the intervention variables has a significant effect on child height, and even taken together they are not significant (*equations 8*).

Although the parameter estimate of UPGK shows a statistically significant difference from zero ($P = 0.030$), the RR is only about 1.1. Here all intervention variables have negative parameter estimates, but breast–feeding status at the time of survey shows a similar association as in the weight–for–age. It should be noted that in addition to the parameter estimate of child's age, mother's age is also statistically significant.

Intervention Effects At The Macro Levels and SES variables Adjusted for Biologic Factors

In contrast with the finding presented in Table 7.13 (*page 255*), the effect of family planning program goes in the opposite direction (*negative coefficient*). Table 7.16 (*page 262*) shows that a strong family planning program at the PHC level may increase the prevalence of stunting children.

Children whose mother's education is below secondary school and children whose mother never heard of immunization show a higher risk of stunting than other children from a reference category. Furthermore, data suggest that increasing income and regional development may reduce the probability of children falling into the stunting category. Similarly, the variable for health program shows a positive parameter estimate, which means that a stronger health program may reduce the probability of stunting. However, the availability of government health services is not associated with the stunting indicator, which is consistent with a previous finding.

Table 7.15: PARAMETER ESTIMATES OF INTERVENTION EFFECTS ON HEIGHT–FOR–AGE ADJUSTED FOR BIOLOGICAL FACTORS† USING A PROPORTIONAL ODDS MODEL FOR ORDINAL DATA

VARIABLES	Eq.1	Eq.2	Eq.3	Eq.4	Eq.5	Eq.6	Eq.7	Eq.8
BIOLOGIC MOTHER'S:								
Age at birth	.015 (.004)	.015 (.004)	.015 (.004)	.015 (.004)	.015 (.004)	.015 (.004)	.016 (.003)	.016 (.002)
CHILD'S AGE								
In Log Month	– .752 (.000)	– .764 (.000)	– .752 (.000)	– .750 (.000)	– .753 (.000)	– .751 (.000)	– .841 (.000)	– .854 (.000)
CHILD'S								
Birth order	–.047 (.120)	–.047 (.122)	–.047 (.123)	–.054 (.096)	–.047 (.123)	–.046 (.123)	–.045 (.133)	–.049 (.120)
(Birth Order)^2	–.009 (.406)	–.001 (.404)	–.001 (.410)	–.001 (.356)	–.001 (.412)	–.001 (.412)	.000 (.458)	–.001 (.422)
HEALTH INTERVENTIONS								
UPGK:								
Nonparticipant		–0.118 (.028)	—	—	—	—	—	–.121 (.030)
ORT								
No Oralit			–.114 (.151)	—	—	—	—	–.086 (.221)
IMMUNIZATION								
Not completed				–.056 (.210)	—	—	—	–.046 (.256)
FAM. PLANNING								
Never used					–.054 (.264)	—	—	–.011 (.448)
TT at ANC								
Never had TT						–.076 (.114)	—	–.041 (.269)
BREASTFEEDING								
Had stopped							.285 (.000)	.297 (.000)
LR Null Model	5838	5838	5838	5838	5838	5838	5838	5838
LR Model	5548	5447	5548	5548	5548	5548	5540	5536
AIC with $\beta = 0$	584.7	588.4	585.8	585.4	585.1	587.2	602.4	608.9
No. of cases	4452	4452	4452	4452	4452	4452	4452	4452

†Note: Three intercept parameters are not presented in the table. P values within parenthesis. The coefficients of each categorial variable represent a contrast with deleted categories.

Table 7.16: PARAMETER ESTIMATES OF INTERVENTION EFFECTS AT THE MACRO LEVEL ON HEIGHT–FOR–AGE ADJUSTED FOR BIOLOGICAL FACTORS† USING A PROPORTIONAL ODDS MODEL FOR ORDINAL DATA

VARIABLES	Eq.1	Eq.2	Eq.3	Eq.4	Eq.5	Eq.6	Eq.7	Eq.8
BIOLOGIC MOTHER'S:								
Age at birth	.015 (.003)	.016 (.002)	.015 (.005)	.015 (.004)	.016 (.003)	.016 (.003)	.014 (.007)	.016 (.002)
CHILD'S AGE								
In Log Month	– .753 (.000)	– .753 (.000)	– .753 (.000)	– .753 (.000)	– .752 (.000)	– .752 (.000)	– .750 (.000)	– .753 (.000)
CHILD'S								
Birth order	–.045 (.136)	–.048 (.116)	–.046 (.126)	–.048 (.116)	–.050 (.108)	–.048 (.116)	–.045 (.134)	–.052 (.101)
(Birth Order)^2	– .001 (.421)	–.002 (.400)	–.001 (.422)	–.001 (.401)	–.001 (.417)	–.001 (.410)	–.001 (.437)	.001 (.384)
SES VARIABLES MOTHER'S								
Educt. <second.	–.171 (.020)	—	—	—	—	—	—	—
Never Heard immunization		–.123 (.014)	—	—	—	—	—	—
LATRINE								
No latrine			–.379 (.000)	—	—	—	—	—
FATHER'S OCC.								
Non Civil/Army				–.249 (.001)	—	—	—	—
EXPENDITURES								
Log in Rp.					.094 (.009)	—	—	—
MACRO VAR.								
Health Program						.310 (.076)	—	—
Family Planning							.609 (.005)	—
Regional Development								.011 (.338)
Availability Services								.273 (.001)
LR Null Model	5838	5838	5838	5838	5838	5838	5838	5838
LR Model	5546	5546	5543	5544	5546	5547	5545	5544
AIC with $\beta = 0$	588.9	589.5	596.2	594.3	590.4	586.8	591.6	593.8
No. of cases	5452	5452	5452	5452	5452	5452	5452	5452

†*Note: Three intercept parameters are not presented in the table. P values within parenthesis. The coefficients of each categorial variable represents contrast with categories deleted*

Intervention Effects Adjusted for Biologic, The Micro and Macro Variables

Adjusting for macro variables did not change previous findings on intervention effects on the nutritional status according to height–for–age (*coefficients across columns did not change*). Table 7.17 (*page 264–265*) shows that only the family planning variable is statistically an important variable in every model.

This means that a stronger family planning program may increase the number of stunting children in the PHC area. The health program effect is statistically important,[8] but its parameter estimate is not statistically different from zero.[9] This table suggests that the health program effects are confounded by other variables, partculary family planning program. Equation 8 table 7.17 shows that the parameter estimate of family planning program increases almost one–third when a health program variable is also included in the model.

In equation 8, mother's education, father's occupation, and income become not statistically different from zero. On the other hand, children who did not have access to a flush latrine facility are almost 1.3 times more likely to fall into the stunting category compared with other children. This table also shows that infrastructure development is an important determinant of stunting.

7.5.3 Determinants of Growth Faltering According to Weight–for–Height

Intervention Effects Adjusted for Biologic Factors

Table 7.18 (*page 266*) shows that mother's and child's ages and birth order are important determinants for the nutritional status accord-

[8] We judged from the LR test, which is not shown in the table.
[9] We judge from Wald's statistics.

Table 7.17: PARAMETER ESTIMATES OF INTERVENTION EFFECTS ON HEIGHT–FOR–AGE ADJUSTED FOR BIOLOGICAL, SES, MACRO VARIABLES† USING A PROPORTIONAL ODDS MODEL FOR ORDINAL DATA

VARIABLES	Eq.1	Eq.2	Eq.3	Eq.4	Eq.5	Eq.6	Eq.7	Eq.8
BIOLOGIC MOTHER'S:								
Age at birth	.016 (.002)	.016 (.003)	.016 (.002)	.016 (.002)	.016 (.003)	.016 (.003)	.015 (.005)	.016 (.003)
CHILD'S AGE								
In Log Month	– .851 (.000)	– .853 (.000)	– .852 (.000)	– .852 (.000)	– .851 (.000)	– .851 (.000)	– .843 (.000)	– .841 (.000)
CHILD'S								
Birth order	–.047 (.129)	–.047 (.126)	–.051 (.111)	–.051 (.109)	–.050 (.114)	–.050 (.114)	–.048 (.122)	–.052 (.103)
(Birth Order)^2	– .001 (.429)	–.001 (.436)	–.001 (.409)	–.001 (.429)	–.001 (.428)	–.001 (.428)	–.001 (.446)	–.001 (.430)
HEALTH INTERVENTIONS								
UPGK:								
Nonparticipant	–.117 (.035)	–.121 (.031)	–.117 (.035)	–.119 (.033)	–.117 (.036)	–.117 (.035)	–.122 (.036)	–.123 (.039)
ORT								
No Oralit	–.068 (.276)	–.063 (.289)	–.058 (.305)	–.072 (.263)	–.042 (.356)	–.041 (.357)	–.022 (.424)	–.028 (.401)
IMMUNIZATION								
Not completed	–.046 (.256)	–.037 (.300)	–.046 (.255)	–.044 (.267)	–.038 (.293)	–.038 (.293)	–.060 (.200)	–.071 (.159)
FAM. PLANNING								
Never used	–.028 (.378)	–.043 (.317)	–.039 (.334)	–.021 (.409)	–.058 (.259)	–.057 (.267)	–.041 (.326)	–.063 (.248)
TT at ANC								
Never had TT	–.026 (.363)	–.013 (.426)	–.004 (.475)	–.021 (.378)	–.015 (.413)	–.014 (.420)	–.006 (.463)	–.010 (.441)
BREASTFEEDING								
Had stopped	.293 (.000)	.290 (.000)	.290 (.000)	.291 (.000)	.284 (.000)	.284 (.000)	.268 (.000)	.262 (.000)
Continued on next page								

Table 7.17: CONTINUED

VARIABLES	Eq.1	Eq.2	Eq.3	Eq.4	Eq.5	Eq.6	Eq.7	Eq.8
SES VARIABLES:								
MOTHER'S								
Educt. <second.	–.131 (.067)	—	—	—	–.004 (.484)	–.004 (.480)	–.024 (.399)	–.003 (.488)
LATRINE								
No latrine		–.345 (.002)	—	—	–.270 (.015)	–.270 (.015)	–.266 (.016)	–.245 (.025)
FATHER'S OCC.								
Non Civil/Army			–.220 (.005)	—	–.141 (.071)	–.144 (.073)	–.176 (.034)	–.107 (.142)
EXPENDITURES								
Log in Rp.				.076 (.030)	.037 (.192)	.038 (.190)	.034 (.214)	.009 (.415)
MACRO VAR.								
Health Program						–.026 (.457)	—	–.245 (.215)
Family Planning							–.765 (.002)	–1.098 (.000)
Regional Development								.260 (.013)
LR Null Model	5838	5838	5838	5838	5838	5838	5838	5838
LR Model	5535	5532	5533	5535	5530	5530	5525	5521
AIC with $\beta = 0$	611.1	617.7	615.6	612.5	621.9	621.9	631.8	639.7
No. of cases	5452	5452	5452	5452	5452	5452	5452	5452

†*Note: Three intercept parameters are not presented in the table. P values within parenthesis. The coefficients of each categorial variable represent a contrast with deleted categories.*

ing to weight–for–height (*wasting*). Most of intervention variables are consistently not significantly different from zero, even when taken together in a single model Only the TT variable shows statistically difference from zero, but RR is about 1.1, which is practically considered as a nonimportant risk factor.

Table 7.18: PARAMETER ESTIMATES OF INTERVENTION EFFECTS ON WEIGHT–FOR–HEIGHT ADJUSTED FOR BIOLOGICAL FACTORS† USING A PROPORTIONAL ODDS MODEL FOR ORDINAL DATA

VARIABLES	Eq.1	Eq.2	Eq.3	Eq.4	Eq.5	Eq.6	Eq.7	Eq.8
BIOLOGIC MOTHER'S:								
Age at birth	–.017 (.003)	–.017 (.003)	–.017 (.003)	–.017 (.003)	–.017 (.003)	–.016 (.003)	–.017 (.003)	–.016 (.004)
CHILD'S AGE								
In Log Month	– .142 (.000)	– .137 (.000)	– .142 (.000)	– .144 (.000)	– .142 (.000)	– .141 (.000)	– .152 (.000)	– .143 (.000)
CHILD'S								
Birth order	.089 (.018)	.089 (.018)	.089 (.018)	.093 (.015)	.089 (.018)	.091 (.017)	.089 (.018)	–.096 (.014)
(Birth Order)^2	–.007 (.030)	–.007 (.030)	–.007 (.030)	–.008 (.027)	–.007 (.031)	–.008 (.029)	–.008 (.029)	–.008 (.024)
HEALTH INTERVENTIONS								
UPGK:								
Nonparticipant		– .055 (.203)	—	—	—	—	—	–.068 (.164)
ORT								
No Oralit			–.040 (.369)	—	—	—	—	–.030 (.401)
IMMUNIZATION								
Not completed				–.038 (.302)	—	—	—	–.045 (.276)
FAM. PLANNING								
Never used					–.017 (.423)	—	—	–.039 (.340)
TT at ANC								
Never had TT						–.094 (.082)	—	–.120 (.050)
BREASTFEEDING								
Had stopped							.035 (.309)	.030 (.337)
LR Null Model	4001	4001	4001	4001	4001	4001	4001	4001
LR Model	3987	3986	3987	3987	3987	3986	3987	3985
AIC with $\beta = 0$	34.2	34.9	34.3	34.5	34.2	36.1	34.5	38.2
No. of cases	4452	4452	4452	4452	4452	4452	4452	4452

†Note: Three intercept parameters are not presented in the table P values within parenthesis. The coefficients of each categorial variable represent a contrast with deleted categories.

Intervention Effects At The Macro Level and SES variables Adjusted for Biologic Factors

Table 7.19 (*page 268*) shows that among SES variables at the individual level only mother's education and household expenditures are significantly different from zero. Both variable health and family planning programs have positive associations with the weight–for–height indicator.

Children who are living in a PHC-CA that has a strong health or family planning program are more likely to be a better nourished. There is no evidence from this table that the availability of government health services and infrastructure development determine the level of the weight–for–height indicator.

Intervention Effects Adjusted for Biologic, The Micro and Macro Variables

Table 7.20 (*page 269–270*) shows that intervention effects have been adjusted for the micro and macro variables simultaneously. At the micro level, none of the intervention variables has a significant effect on weight, even when taken together in a single model. An independent effect of family planning program at PHC shows a very strong association with the prevalence of wasting, whereas health program effects are diminished by adjusting for interventions and other macro variables. There are also independent effects of mother's education and household income for the wasting indicator.

Table 7.19: PARAMETER ESTIMATES OF INTERVENTION EFFECTS AT THE MACRO LEVEL ON WEIGHT–FOR–HEIGHT ADJUSTED FOR BIOLOGICAL FACTORS† USING A PROPORTIONAL ODDS MODEL FOR ORDINAL DATA

VARIABLES	Eq.1	Eq.2	Eq.3	Eq.4	Eq.5	Eq.6	Eq.7	Eq.8
BIOLOGIC MOTHER'S:								
Age at birth	–.016 (.004)	–.016 (.002)	–.017 (.003)	–.017 (.003)	–.017 (.002)	–.016 (.005)	–.015 (.007)	–.017 (.003)
CHILD'S AGE								
In Log Month	– .141 (.000)	– .142 (.000)	– .143 (.000)	– .143 (.000)	– .143 (.000)	– .143 (.000)	– .150 (.000)	– .142 (.000)
CHILD'S								
Birth order	–.092 (.015)	–.089 (.018)	–.089 (.018)	–.089 (.018)	–.091 (.015)	–.088 (.116)	–.083 (.026)	–.088 (.019)
(Birth Order)^2	– .008 (.028)	–.007 (.030)	–.007 (.031)	–.007 (.030)	–.007 (.032)	–.007 (.030)	–.007 (.045)	.007 (.033)
SES VARIABLES MOTHER'S								
Educt. <second.	–.180 (.024)	—	—	—	—	—	—	—
Never Heard immunization		–.084 (.081)	—	—	—	—	—	—
LATRINE								
No latrine			–.102 (.190)	—	—	—	—	—
FATHER'S OCC.								
Non Civil/Army				–.105 (.111)	—	—	—	—
EXPENDITURES Log in Rp.					–.077 (.033)	—	—	—
MACRO VAR.								
Health Program						.429 (.034)	—	—
Family Planning							1.481 (.000)	—
Regional Development								.024 (.206)
Availability Services								–.088 (.182)
LR Null Model	4001	4001	4001	4001	4001	4001	4001	4001
LR Model	3985	3986	3986	3986	3985	3985	3969	3986
AIC with $\beta = 0$	38.2	36.2	35.0	35.7	37.6	37.6	69.3	36.0
No. of cases	4452	4452	4452	4452	4452	4452	4452	4452

†*Note: Nine intercept parameters are not presented in the table. P values within parenthesis. The coefficients of each categorial variable represent a contrast with deleted categories.*

Table 7.20: PARAMETER ESTIMATES OF INTERVENTION EFFECTS ON WEIGHT–FOR–HEIGHT ADJUSTED FOR BIOLOGICAL, SES, MACRO VARIABLES† USING A PROPORTIONAL ODDS MODEL FOR ORDINAL DATA

VARIABLES	Eq.1	Eq.2	Eq.3	Eq.4	Eq.5	Eq.6	Eq.7	Eq.8
BIOLOGIC MOTHER'S:								
Age at birth	–.016 (.004)	–.016 (.004)	–.016 (.004)	–.017 (.003)	–.016 (.004)	–.015 (.006)	–.014 (.010)	–.015 (.007)
CHILD'S AGE								
In Log Month	– .139 (.000)	– .143 (.000)	– .142 (.000)	– .145 (.000)	– .141 (.000)	– .141 (.000)	– .158 (.000)	– .161 (.000)
CHILD'S								
Birth order	.097 (.013)	.095 (.014)	.095 (.014)	.099 (.011)	.101 (.010)	.099 (.011)	.098 (.012)	.103 (.009)
(Birth Order)^2	– .008 (.024)	–.008 (.025)	–.008 (.025)	–.008 (.025)	–.007 (.026)	–.008 (.026)	–.008 (.031)	–.008 (.029)
HEALTH INTERVENTIONS								
UPGK:								
Nonparticipant	.072 (.148)	.068 (.164)	.069 (.158)	.066 (.170)	.074 (.142)	.082 (.119)	.082 (.118)	–.086 (.108)
ORT								
No Oralit	–.005 (.483)	–.041 (.370)	–.019 (.439)	–.052 (.337)	–.024 (.424)	–.032 (.396)	–.066 (.297)	–.058 (.318)
IMMUNIZATION								
Not completed	.043 (.283)	.041 (.293)	.045 (.275)	.044 (.281)	.037 (.313)	.037 (.313)	.081 (.141)	.094 (.108)
FAM. PLANNING								
Never used	.283 (.062)	.027 (.387)	.050 (.299)	.026 (.390)	.052 (.295)	.074 (.221)	.088 (.180)	.068 (.243)
TT at ANC								
Never had TT	–.096 (.094)	–.132 (.035)	–.105 (.078)	–.144 (.025)	–.117 (.058)	–.098 (.096)	–.076 (.158)	–.093 (.108)
BREASTFEEDING								
Had stopped	.025 (.363)	.032 (.325)	.027 (.352)	.037 (.304)	.031 (.330)	.034 (.317)	.066 (.183)	.075 (.152)
Continued on next page								

Table 7.20: CONTINUED

VARIABLES	Eq.1	Eq.2	Eq.3	Eq.4	Eq.5	Eq.6	Eq.7	Eq.8
SES VARIABLES:								
MOTHER'S								
Educt. <second.	–.174 (.034)	—	—	—	–.222 (.018)	–.207 (.026)	–.181 (.045)	–.221 (.020)
LATRINE								
No latrine		–.136 (.129)	—	—	–.191 (.069)	–.193 (.068)	–.175 (.087)	–.138 (.143)
FATHER'S OCC.								
Non Civil/Army			–.088 (.168)	—	–.117 (.130)	–.079 (.228)	–.047 (.326)	–.126 (.121)
EXPENDITURES								
Log in Rp.				–.092 (.016)	–.117 (.005)	–.123 (.004)	–.114 (.006)	–.083 (.037)
MACRO VAR.								
Health Program						.425 (.056)	—	–.090 (.394)
Family Planning							1.521 (.000)	1.904 (.000)
Regional Development								.416 (.000)
LR Null Model	4001	4001	4001	4001	4001	4001	4001	4001
LR Model	3983	3984	3984	3983	3978	3977	3961	3955
AIC with $\beta = 0$	41.5	39.5	39.1	42.8	51.3	53.8	85.1	98.7
No. of cases	4452	4452	4452	4452	4452	4452	4452	4452

†*Note: Three intercept parameters are not presented in the table. P values within parenthesis. The coefficients of each categorial variable represent a contrast with deleted categories.*

7.6 SUMMARY OF DETERMINANTS OF NUTRITIONAL STATUS

Children under 5 years old showed considerably more stunting than wasting (*56.7 percent versus 16.8 percent*), and about 36 percent were underweight.[10] More than 5 percent fell into the "stunting plus wasting" category. These rates are higher than those found in other parts

[10] We defined children with underweight, stunted, and wasted if their weight–for–age, height–for–age, and height–for–age were below -2 Z–Scores using the NCHS/CDC standard (*Jordan, 1987*).

of Indonesia (*Budiarsa et al., 1986; CBS, 1987; Kardjati et al., 1979*), but are very similar to rates found in other studies in India, Nepal, and Sri Lanka (*Steinhoff et al., 1986*).

Data show that growth faltering in children varies with age. There are significant increases in the prevalence of stunting and wasting after age 6 months, with the peak of wasting at age 12–23 months. Although it is possible that genetic factors may have contributed to the high rate of growth faltering in this population, it cannot be ruled out that high prevalence of growth faltering may be associated with relatively poor socioeconomic conditions compared to the rest of the Indonesian population.

There is a variation of prevalence of growth faltering between urban and rural areas. The rural area has a higher prevalence malnutrition than the urban, except for wasting, which shows a prevalence rate higher in urban than rural.

All analyses use three different dependent variables. An explanatory variable that can be linked with weight–for–age may not be a significant predictor for either height–for–age or weight–for–height. At the aggregate level, most intervention variables can be linked with the prevalence of underweight or wasting. Except for percentage of households with ORS and proportion of MWRA ever used contraception, the prevalence of stunting does not seem to have an association with other child survival interventions. There is, however, some indication that a PHC with more contraceptive users is likely to have a greater number of stunted children, but it will have fewer "underweight" and "wasted" children. Similarly, increasing both child survival interventions and health inputs may increase prevalence of stunting, but they decrease the prevalence of underweight or wasting children under 5 years old. Aggregate analyses also suggest that prevalence of underweight can be linked to regional development and mean of income, but regional development and mean of income cannot be linked directly to the prevalence of stunting or wasting.

At the aggregate level, there is no a correlation between the number of health workers or staff medics and participation in UPGK, ORT, and family planning programs, or utilization of immunization and ANC. However, a social setting is a significant factor in the utilization of child survival interventions. This suggests that the utilization of child survival intervention is perhaps less determined by the supply of providers and more strongly determined by patients' demand.

There are strong correlations between the utilization of immunization with ANC and family planning programs at the aggregate analysis. But UPGK shows weaker correlations with ANC and family planning programs. ORT program does not correlate with any other child survival programs.

Multivariable analysis showed that growth monitoring, ORT, immunization, and TT at ANC show no independent effects on the probability of becoming underweight, stunting, and wasting for children unde 5 years old. Although most parameter estimates of effects associated with these variable are below zero (*risks of nonusers interventions are higher than users interventions*), but most of them are not statistically different from zero. At the PHC level, strength of health program shows no independent effect in all nutritional status indicators. The effects of health program on risks of underweight, stunting and wasting are confounded by interventions, regional development factors, and a family planning program. However because of the effects of intervention variables at the micro level are not statistically significant, the effect of health program is likely mediated by other variables, which may not be in our models.

The strength of family planning program shows strong associations with prevalence of underweight and wasting. When a family planning program has been adopted, children living in this area are less likely to be underweight or wasting. However, these children are more likely to be stunted, which may suggest that many children were suffering from chronic malnutrition. It is possible that these children suffer from frequent illnesses, but because of indirect effects of family planning programs they survive and, more importantly, have a low risk of being underweight.

Mother's education, father's occupation, health knowledge on immunization, income, and the availability of latrine facility are associated with underweight, stunting and wasting for children under 5 years old. On the determinant of stunting, when family planning variables were considered in the analyses, only the availability of latrine facility has an independent effect. It should be noted that stunting is determined by the regional development indicators; children who live in more developed PHC areas have lower probability of stunting.

Chapter 8

THE INDEX OF HEALTH STATUS

8.1 INTRODUCTION

This chapter examines the determinants of child health based on a new index of health status. The analytical frameworks and statistical models defined in chapter 3 will be used in this analysis. All statistical models use child survival interventions as explanatory variables and the new index of health status (*which combines nutritional status and mortality*) as the dependent variable. To test that the new indicator of child health status is a useful tool in evaluation of child survival interventions, we will compare between models using the index of health status as the dependent variable and models using either mortality (*chapter 6*) or nutritional status (*chapter 7*) alone as the dependent variable. Comparability between models will be judged based on the direction of association and the size of parameter estimate (*mainly using RR*) of each explanatory variable.

8.2 DEFINITION AND ASSUMPTION

Mosley and Chen (*1984*) proposed a conceptual framework for the study of child survival (*among a cohort of children*) in LDCs, which included measuring nutritional status among survival as well and mortality data as an outcome(*a dependent variable*). They suggested using a Gomez's classification which includes four grades of nutritional status (*0, I, II, III*) and assigning child death at grade IV as an outcome variable. Our index of health status also includes four grades of nutritional status (*0, I, II, and III*) and assigns a child death at grade IV as an outcome variable, but for the grade of nutritional status we do not use a Gomez's classification (*Gomez, 1956*). We use a similar ordinal scales, but with different cutpoints, as in chapter 7. For all nutritional status indicators (*weight–for–age, height–for–age, and weight–for–height*), we consider under–5 children with a Z–score

equal to or above -1 as grade 0 (*normal*), below -1 to -2 Z–score as a grade I, -2 to -3 as a grade II, and below -3 as a grade III of growth faltering. These grades are automatically assigned as categories of index of health status. In addition to growth faltering data from survivors, then all deaths of children born within 5 years before the survey dates are assigned as grade IV subjects. So we have the index of health status as an ordinal scale variable with 5 possible values (*5 categories*).

Under our definition, we assume that the health status is a continuous latent variable (*defined as Z in chapter 3*), which has a normal distribution with a mean equal zero and a variance equal to one. If only the Z–score contributes to the index of health status, this assumption is implicitly given by the Z-score definition. But by adding child death as category 4, we have to further assume that category 4 is placed in the lowest tail of distribution (*Z-score below* -7.8 *as a the lowest possible Z-score in our sample*). So by definition, death is always assumed to be the worst outcome of child survival interventions.

We also assumed that if the probability that the observed value for the index of health status (*defined as* Y *in chapter 3*) takes on successively higher values rises (*or falls*) slowly at small values of all explanatory variables (*vector* x_i), more rapidly for intermediate values of x_i, and more slowly again at large values of x_i then the proportional odds is appropriate for our model. This assumption is required for our proportional odds model since this model has "a link function" as a logit form.

It should be noted that our proportional odds models do not allow some covariates to follow a proportional assumption. Our model requires the assumption of proportionality so that the difference between corresponding cummulative logits of $\boldsymbol{Y}$ is independent of the category involved. This implies that in the hypothetical population for which this sample was drawn, the odds ratio for each of two possible dichotomous are the same.[1] This assumption is required for our proportional odds model.

It should be noted that our proportional odds models do not allow some covariates to follow a proportional assumption. Recently, Peterson and Harrell et al. (*1990*) proposed a partial proportional odds model that allows some covariate effects not to follow the proportional assumption.

[1]As a prelimanary investigation of adequacy of proportional odds model, we followed MCullagh's suggesstion (*1980*). We examined each explanatory variable, and only UPGK variable violated the proportionality assumption.

8.3 DETERMINANTS OF HEALTH STATUS

Following the conceptual framework discussed in chapter 3, we present the results of regressing the index of health status on a set of child survival interventions. Mother's age, birth order, and child's age are biologically important as determinants of the index of health status. Therefore these variables are retained in the models. Retaining these variable will allow comparability of current models with previous mortality and nutritional status analyses. We considered the same intervention variables, which had been examined in the determinants of nutritional status, and in a survival analysis. These variables are UPGK, ORT, contraceptive use, TT at ANC, immunization, and breast–feeding status. Mother's education, father's occupation, access to a latrine facility, and income will also be examined in this section. Macro variables on the proxies for health and family planning programs, availability of health services, and a regional development are also considered in the following health status models.

8.3.1 The Index of Health Status Involving Weight–for–Age

Intervention Effects Adjusted for Biological Factors

Table 8.1 (*page 278*) shows parameter estimates of intervention effects on health status derived from child's weight–for–age. These effects have been adjusted for mother's and child's ages and child birth order. As in the nutritional status model, child's age is transformed into a natural logarithm scale. A quadratic term of birth order is also included in model to capture a nonlinear effect of birth order. Among these biologic factors, only a child's age is statistically signif-

Table 8.1: PARAMETER ESTIMATES OF INTERVENTION EFFECTS ON THE INDEX OF HEALTH STATUS INVOLVING WEIGHT–FOR–AGE ADJUSTED FOR BIOLOGICAL FACTORS† USING A PROPORTIONAL ODDS MODEL FOR ORDINAL DATA

VARIABLES	Eq.1	Eq.2	Eq.3	Eq.4	Eq.5	Eq.6	Eq.7	Eq.8
BIOLOGIC MOTHER'S:								
Age at birth	–.009 (.070)	–.008 (.072)	–.009 (.073)	–.009 (.065)	–.009 (.073)	–.008 (.076)	–.009 (.067)	–.009 (.071)
CHILD'S AGE								
In Log Month	– .445 (.000)	– .483 (.000)	– .445 (.000)	– .439 (.000)	– .451 (.000)	– .442 (.000)	– .423 (.000)	– .462 (.000)
CHILD'S								
Birth order	.063 (.067)	.062 (.066)	.064 (.063)	.043 (.155)	.065 (.059)	.064 (.061)	.062 (.069)	.052 (.113)
(Birth order)^2	–.005 (.076)	–.006 (.079)	–.006 (.073)	–.004 (.157)	–.006 (.069)	–.006 (.073)	–.006 (.082)	–.005 (.127)
HEALTH INTERVENTIONS								
UPGK:								
Nonparticipant		–0.335 (.000)	—	—	—	—	—	–.291 (.000)
ORT								
No Oralit			–.172 (.071)	—	—	—	—	–.087 (.234)
IMMUNIZATION								
Not completed				–.173 (.008)	—	—	—	–.115 (.059)
FAM. PLANNING								
Never used					–.218 (.007)	—	—	–.090 (.167)
TT at ANC								
Never had TT						–.151 (.010)	—	–.050 (.238)
BREASTFEEDING								
Had stopped							–.078 (.131)	–.048 (.248)
LR Null Model	5371	5371	5371	5371	5371	5371	5371	5371
LR Model	5277	5263	5276	5274	5274	5274	5276	5260
AIC with $\beta = 0$	195.3	223.0	197.5	201.0	201.0	200.7	196.6	229.4
No. of cases	4715	4715	4715	4715	4715	4715	4715	4715

†*Note: Four intercept parameters are not presented in the table. P values within parenthesis. The coefficients of each categorial variable represent a contrast with deleted categories.*

icant, although mother's age and child birth order are barely significant. Clearly increasing of child's age will increase the risk of having lower health status, namely by an increased chance of becoming grade II or above. It should be noted that both mother's age and the quadratic term of birth order have a negative coefficient; but mother's age has no a practical importance.

Equations 2 to 7 show parameter estimates of UPGK, Oralit, immunization status, contraceptive use, TT at ANC, and breast–feeding status at the time of survey respectively. These numbers have been adjusted for mother's and child's age, birth order, and a quadratic term of birth order. Equation 8 shows all intervention variables in the single model, which have also been adjusted to biologic factors as in equations 2 to 7.

If we consider each of child survival interventions individually (*equations 2 to 7*), children who did not receive one of these interventions have at least 1.2 times higher risk of falling into a low health status category (*a category higher than grade 2, which could be either death or underweight*). Children who did not attend growth monitoring have the highest risk of low health status, while children whose mothers did not receive TT at ANC have the lowest relative risk estimate. In between, the order of relative risks are those associated with contraception, immunization, and ORT respectively. Under this model, breast–feeding status shows no important risk factor for the level of health status. [2]

After all intervention variables are given in the single model (*equation 8*), there are two important figures found in this model. First, the

[2] We have to follow our previous convention in chapter 3, which is to reverse the sign of parameter estimate. To obtain relative risk, we take an exponential of this parameter estimate (*after reversing the sign*).

parameter estimate of UPGK is declining from $-.335$ to $-.291$. Second, except the parameter estimates of UPGK, other parameter estimates of interventions become not statistically significant. This finding shows that besides UPGK's independent effects to health status, other child survival interventions are also confounded by UPGK. This may suggest that UPGK may affect the utilization of other child survival interventions.

Intervention Effects at The Macro Levels and SES Adjusted for Biologic Factors

Table 8.2 (*page 281*) shows effects of health and family planning programs at the macro level (*equations 6 and 7*) and socioeconomic status at the micro level (*equations 1 to 5*) on the index of health status involving weight–for–age. The availability of health services and a proxy for regional development are also included in the table (*equations 8*). All equations have been adjusted for mother's and child's age, birth order, and a quadratic term of birth order.

Health and family planning programs show important associations with the index of health status, which go in the expected direction. A stronger family or health program can improve child health status involving weight–for–age. Similarly, increasing regional development may improve child health status. However, as in previous analyses, the availability of services (*measured as a logarithm of distances from home to the nearest of government health care facility*) shows no significant association.

Children whose mother's education is lower than high school show a higher risk of having a low health status compared with children whose mothers education is high school and above (*RR=1.5*). Similarly, children whose mother never heard the word "immunization", whose

Table 8.2: PARAMETER ESTIMATES OF INTERVENTION EFFECTS AT THE MACRO LEVEL ON THE INDEX OF HEALTH STATUS INVOLVING WEIGHT–FOR–AGE ADJUSTED FOR BIOLOGICAL FACTORS† USING A PROPORTIONAL ODDS MODEL FOR ORDINAL DATA

VARIABLES	Eq.1	Eq.2	Eq.3	Eq.4	Eq.5	Eq.6	Eq.7	Eq.8
BIOLOGIC MOTHER'S:								
Age at birth	–.008 (.098)	–.007 (.115)	–.009 (.066)	–.008 (.084)	–.008 (.078)	–.007 (.105)	–.007 (.103)	–.008 (.092)
CHILD'S AGE								
In Log Month	– .443 (.000)	– .446 (.000)	– .445 (.000)	– .447 (.000)	– .449 (.000)	– .445 (.000)	– .448 (.000)	– .445 (.000)
CHILD'S								
Birth order	.069 (.050)	.061 (.070)	.063 (.065)	.069 (.068)	.061 (.071)	.062 (.069)	.059 (.078)	.057 (.085)
(Birth order)^2	– .006 (.065)	–.006 (.080)	–.005 (.073)	–.006 (.075)	–.006 (.072)	–.006 (.072)	–.005 (.090)	.005 (.091)
SES VARIABLES MOTHER'S								
Educt. <second.	–.388 (.000)	—	—	—	—	—	—	—
Never Heard immunization		–.223 (.000)	—	—	—	—	—	—
LATRINE								
No latrine			–.269 (.010)	—	—	—	—	—
FATHER'S OCC.								
Non Civil/Army				–.376 (.000)	—	—	—	—
EXPENDITURES								
Log in Rp.					.071 (.041)	—	—	—
MACRO VAR.								
Health Program						.564 (.006)	—	—
Family Planning							.813 (.000)	—
Regional Development								.212 (.012)
Availability Services								.041 (.071)
LR Null Model	5371	5371	5371	5371	5371	5371	5371	5371
LR Model	5267	5270	5274	5267	5276	5274	5271	5274
AIC with $\beta = 0$	215.1	209.9	200.7	215.7	198.7	201.6	206.7	201.7
No. of cases	4715	4715	4715	4715	4715	4715	4715	4715

†*Note: Four intercept parameters are not presented in the table. P values within parenthesis. The coefficients of each categorial variable represent a contrast with deleted categories.*

father's occupation is non–*pegawai negeri* or non–ABRI, and who did not have a flush latrine are more likely to have a low health status. Increasing income may reduce risk of having a low health status. Thus all SES variables can be directly associated with child health status (*without considering child survival interventions in the models*).

Intervention Effects Adjusted for Biologic, The Micro and Macro Variables

Table 8.3 (*page 283–284*) shows intervention effects, which have been adjusted for biologic and SES variables and other macro variables. Effects of adjusting for mother's education, availability of latrine facility, father's occupation, and household expenditures on intervention variables can be seen in equations 1 to 4 respectively.

By comparing each coefficient across columns, the numbers suggest that there is not much change in the parameter estimates of intervention variables. Similarly, adjusting for health and family planning programs and the regional development indicator does not change the numbers significantly. Among intervention variables, only adoption of growth monitoring has an independent effect and a meaningful coefficient (*RR=1.3*), while immunization becomes not statistically significant. However, the signs of all intervention variables are in the right direction.

The independent effect of a family planning program suggests that children living in PHC area with a strong family planning program are likely to be healthier compared with other children, who are living in the area where a family planning program has not been adopted. Equation 8 shows that mother's education and father's occupation have independent effects on the child health status involving weight–for–age. There is no evidence that a regional development in-

Table 8.3: PARAMETER ESTIMATES OF INTERVENTION EFFECTS ON THE INDEX OF HEALTH STATUS INVOLVING WEIGHT–FOR–AGE ADJUSTED FOR BIOLOGICAL, SES, MACRO VARIABLES† USING A PROPORTIONAL ODDS MODEL FOR ORDINAL DATA

VARIABLES	Eq.1	Eq.2	Eq.3	Eq.4	Eq.5	Eq.6	Eq.7	Eq.8
BIOLOGIC MOTHER'S:								
Age at birth	–.008 (.090)	–.008 (.067)	–.008 (.078)	–.009 (.075)	–.008 (.088)	–.008 (.086)	–.007 (.107)	–.008 (.102)
CHILD'S AGE								
In Log Month	– .457	– .461	– .460	– .461	– .457	– .457	– .457	– .462
	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
CHILD'S								
Birth order	.055 (.098)	.052 (.112)	.050 (.123)	.050 (.118)	.052 (.108)	.053 (.107)	.052 (.111)	.053 (.105)
$(\text{Birth order})^2$	– .005 (.120)	–.004 (.124)	–.005 (.131)	–.005 (.124)	–.005 (.126)	–.005 (.126)	–.005 (.130)	–.005 (.126)
HEALTH INTERVENTIONS								
UPGK:								
Nonparticipant	–.282 (.000)	–.291 (.000)	–.285 (.000)	–.290 (.000)	–.281 (.000)	–.282 (.000)	–.278 (.000)	–.276 (.000)
ORT								
No Oralit	–.039 (.374)	–.072 (.275)	–.041 (.366)	–.076 (.262)	–.019 (.262)	–.018 (.440)	–.032 (.396)	–.030 (.402)
IMMUNIZATION								
Not completed	–.119 (.053)	–.111 (.066)	–.115 (.059)	–.115 (.060)	–.117 (.056)	–.117 (.056)	–.103 (.082)	–.101 (.087)
FAM. PLANNING								
Never used	–.046 (.313)	–.075 (.211)	–.049 (.299)	–.085 (.185)	–.028 (.385)	–.031 (.374)	–.017 (.426)	–.021 (.408)
TT at ANC								
Never had TT	–.006 (.464)	–.034 (.317)	–.004 (.478)	–.038 (.294)	–.019 (.319)	–.017 (.405)	–.031 (.329)	–.028 (.348)
BREASTFEEDING								
Had stopped	–.056 (.214)	–.111 (.066)	–.058 (.205)	–.051 (.232)	–.060 (.195)	–.060 (.194)	–.050 (.237)	–.048 (.245)
Continued on next page								

Table 8.3: CONTINUED

VARIABLES	Eq.1	Eq.2	Eq.3	Eq.4	Eq.5	Eq.6	Eq.7	Eq.8
SES VARIABLES:								
MOTHER'S								
Educt. <second.	–.326 (.000)	—	—	—	–.231 (.011)	–.233 (.011)	–.218 (.015)	–.227 (.013)
LATRINE								
No latrine		–.189 (.057)	—	—	–.029 (.408)	–.030 (.407)	–.032 (.399)	–.041 (.373)
FATHER'S OCC.								
Non Civil/Army			–.321 (.000)	—	–.238 (.008)	–.243 (.008)	–.217 (.015)	–.236 (.010)
EXPENDITURES								
Log in Rp.				.045 (.143)	–.013 (.386)	–.012 (.405)	–.011 (.401)	–.003 (.471)
MACRO VAR.								
Health Program						–.057 (.412)	—	—
Family Planning							.461 (.033)	.543 (.021)
Regional Development								–.102 (.180)
LR Null Model	5371	5371	5371	5371	5371	5371	5371	5371
LR Model	5254	5259	5253	5260	5251	5251	5249	5249
AIC with $\beta = 0$	242.0	231.9	242.7	230.0	248.3	248.4	251.7	252.5
No. of cases	4715	4715	4715	4715	4715	4715	4715	4715

†*Note: Four intercept parameters are not presented in the table. P values within parenthesis. The coefficients of each categorial variable represent a contrast with deleted categories.*

dicator has an independent effect after all child survival intervention variables are considered in the model.

8.3.2 The Index of Health Status Involving Height–for–Age

Intervention Effects Adjusted for Biological Factors

Following previous analyses, Table 8.4 (*page 285*) shows intervention effects on the health status indicator involving height–for–age. These effects have also been adjusted for biologic factors. The adoption of

Table 8.4: PARAMETER ESTIMATES OF INTERVENTION EFFECTS ON THE INDEX OF HEALTH STATUS INVOLVING HEIGHT–FOR–AGE ADJUSTED FOR BIOLOGICAL FACTORS† USING A PROPORTIONAL ODDS MODEL FOR ORDINAL DATA

VARIABLES	Eq.1	Eq.2	Eq.3	Eq.4	Eq.5	Eq.6	Eq.7	Eq.8
BIOLOGIC MOTHER'S:								
Age at birth	.004 (.244)	.004 (.245)	.004 (.237)	.003 (.259)	.004 (.239)	.004 (.233)	.003 (.260)	.003 (.260)
CHILD'S AGE								
In Log Month	– .315 (.000)	– .354 (.000)	– .315 (.000)	– .310 (.000)	– .319 (.000)	– .313 (.000)	– .283 (.000)	– .324 (.000)
CHILD'S								
Birth order	.018 (.320)	.020 (.306)	.019 (.313)	.000 (.491)	.020 (.301)	.020 (.302)	.017 (.330)	.007 (.429)
(Birth order)^2	–.003 (.249)	–.003 (.247)	–.003 (.244)	–.001 (.405)	–.003 (.234)	–.003 (.240)	–.002 (.265)	–.001 (.357)
HEALTH INTERVENTIONS								
UPGK:								
Nonparticipant		–0.346 (.000)	—	—	—	—	—	–.316 (.000)
ORT								
No Oralit			–.121 (.126)	—	—	—	—	–.043 (.344)
IMMUNIZATION								
Not completed				–.167 (.005)	—	—	—	–.116 (.042)
FAM. PLANNING								
Never used					–.161 (.023)	—	—	–.042 (.312)
TT at ANC								
Never had TT						–.114 (.028)	—	–.023 (.372)
BREASTFEEDING								
Had stopped							–.111 (.040)	–.082 (.100)
LR Null Model	6852	6852	6852	6852	6852	6852	6852	6852
LR Model	6795	6778	6794	6794	6793	6795	6794	6775
AIC with $\beta = 0$	122.8	157.8	124.1	129.3	126.7	126.4	125.8	163.7
No. of cases	4715	4715	4715	4715	4715	4715	4715	4715

†*Note: Four intercept parameters are not presented in the table. P values within parenthesis.. The coefficients of each categorial variable represents contrast with deleted categories.*

growth monitoring, contraception, and immunization show an important association with child health status. However, when all intervention variables are included in a single model (*equation 8*), only UPGK has an independent association. Although the immunization variable is significantly different from zero, its RR is small (*RR*=1.1). As in the child health status involving weight–for–age, all parameter estimates of intervention variables are in the expected direction (*below zero or may increase relative risks*).

Intervention Effects at The Macro Levels and SES Adjusted for Biologic Factors

Equation 7 in Table 8.5 (*page 287*) shows that strong family planning programs at PHC level may increase risks of having low health status involving height–for–age. This finding is consistent with our previous analysis on nutritional status according to height–for–age. However, health program and regional development show that these may reduce the risk of having low child health status, while availability of health services shows no significant association.

Children whose mother's education is below secondary school and children whose mother has never heard of immunization show a higher risk of having low health status than the reference category. Furthermore, data suggest that increasing of household expenditure (*proxy for income*) may reduce the probability of children falling into the category for low health status. These findings are consistent with the findings from previous analyses on the nutritional status indicator using height–for–age.

Table 8.5: PARAMETER ESTIMATES OF INTERVENTION EFFECTS AT THE MACRO LEVEL ON THE INDEX OF HEALTH STATUS INVOLVING HEIGHT–FOR–AGE ADJUSTED FOR BIOLOGICAL FACTORS† USING A PROPORTIONAL ODDS MODEL FOR ORDINAL DATA

VARIABLES	Eq.1	Eq.2	Eq.3	Eq.4	Eq.5	Eq.6	Eq.7	Eq.8
BIOLOGIC MOTHER'S:								
Age at birth	.004 (.206)	.005 (.194)	.003 (.260)	.004 (.221)	.004 (.210)	.005 (.199)	.003 (.277)	.005 (.180)
CHILD'S AGE								
In Log Month	– .313 (.000)	– .315 (.000)	– .315 (.000)	– .316 (.000)	– .315 (.000)	– .316 (.000)	– .314 (.000)	– .316 (.000)
CHILD'S								
Birth order	.002 (.280)	.017 (.326)	.019 (.308)	.017 (.329)	.015 (.348)	.017 (.327)	.020 (.304)	.013 (.367)
(Birth order)^2	– .003 (.231)	–.002 (.252)	–.003 (.236)	–.002 (.253)	–.003 (.235)	–.003 (.244)	–.003 (.233)	–.002 (.272)
SES VARIABLES MOTHER'S								
Educt. <second.	–.255 (.001)	—	—	—	—	—	—	—
Never Heard immunization		–.118 (.014)	—	—	—	—	—	—
LATRINE								
No latrine			–.364 (.000)	—	—	—	—	—
FATHER'S OCC.								
Non Civil/Army				–.289 (.000)	—	—	—	—
EXPENDITURES								
Log in Rp.					.115 (.001)	—	—	—
MACRO VAR.								
Health Program						.360 (.040)	—	—
Family Planning							–.397 (.036)	—
Regional Development								.307 (.000)
Availability Services								.014 (.292)
LR Null Model	6852	6852	6852	6852	6852	6852	6852	6852
LR Model	6790	6793	6789	6788	6790	6794	6793	6789
AIC with $\beta = 0$	133.0	127.6	134.5	137.1	132.4	125.8	126.0	135.5
No. of cases	4715	4715	4715	4715	4715	4715	4715	4715

†*Note: Four intercept parameters are not presented in the table. P values within parenthesis. The coefficients of each categorial variable represent a contrast with deleted categories.*

Intervention Effects Adjusted for Biologic, The Micro and Macro Variables

Table 8.6 (*page 289–290*) shows results of parameter estimates of intervention variables after being adjusted for micro and macro variables simultaneously. In most cases, adjusting for macro variables did not change previous parameter estimates.

Only UPGK and immunization can be associated with the index of health status involving height–for–age, although the immunization coefficient is a low (RR=1.15). The health program effect becomes not statistically significant (*the sign reverses*), but family planning program is still negatively associated with the health status index. Thus increasing of family planning program will <u>increase</u> the probability of children with a poor health status, which corresponding to the previous finding for stunting. Equation 8 shows evidence that mother's education, availability of latrine, father's occupation, and household income may affect outcome through other variables, presumably child survival interventions (*SES variables are not significant here*). Equation 8 also shows that regional development has an independent effect on the index health status involving height–for–age.

8.3.3 The Index of Health Status Involving Weight–for–Height

Intervention Effects Adjusted for Biological Factors

Except for the parameter estimate of UPGK, all intervention variables are not statistically significant. However, Table 8.7 (*page 291*) also shows that all sign coefficient of intervention variables go in the right direction (*negative signs*). It should be noted that all parameter estimates of biological factors are significantly different from zero.

Table 8.6: PARAMETER ESTIMATES OF INTERVENTION EFFECTS ON THE INDEX OF HEALTH STATUS INVOLVING HEIGHT–FOR–AGE ADJUSTED FOR BIOLOGICAL, SES, MACRO VARIABLES† USING A PROPORTIONAL ODDS MODEL FOR ORDINAL DATA

VARIABLES	Eq.1	Eq.2	Eq.3	Eq.4	Eq.5	Eq.6	Eq.7	Eq.8
BIOLOGIC MOTHER'S:								
Age at birth	.004 (.233)	.003 (.280)	.004 (.247)	.004 (.234)	.004 (.240)	.003 (.262)	.003 (.301)	.003 (.270)
CHILD'S AGE								
In Log Month	– .320	– .322	– .321	– .321	– .319	– .319	– .311	– .310
	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
CHILD'S								
Birth order	.009 (.405)	.008 (.418)	.005 (.451)	.004 (.460)	.006 (.444)	.006 (.438)	.007 (.428)	.003 (.467)
(Birth order)^2	– .001 (.347)	–.001 (.343)	–.001 (.371)	–.001 (.347)	–.001 (.347)	–.001 (.347)	–.002 (.329)	–.001 (.352)
HEALTH INTERVENTIONS								
UPGK:								
Nonparticipant	–.310 (.000)	–.315 (.000)	–.310 (.000)	–.313 (.000)	–.308 (.000)	–.312 (.000)	–.314 (.000)	–.319 (.000)
ORT								
No Oralit	–.014 (.447)	–.021 (.421)	–.011 (.459)	–.023 (.415)	–.012 (.457)	–.016 (.443)	–.033 (.382)	–.027 (.401)
IMMUNIZATION								
Not completed	–.116 (.041)	–.107 (.055)	–.116 (.041)	–.113 (.045)	–.109 (.051)	–.109 (.051)	–.131 (.026)	–.140 (.019)
FAM. PLANNING								
Never used	–.015 (.428)	–.014 (.433)	–.011 (.450)	–.030 (.369)	–.010 (.452)	–.000 (.499)	–.007 (.467)	–.005 (.478)
TT at ANC								
Never had TT	.006 (.463)	.006 (.465)	–.021 (.374)	–.005 (.468)	–.045 (.246)	–.037 (.288)	–.023 (.358)	–.035 (.298)
BREASTFEEDING								
Had stopped	–.086 (.088)	–.088 (.084)	.089 (.080)	.089 (.081)	.096 (.066)	.097 (.065)	.112 (.041)	.117 (.034)
Continued on next page								

Table 8.6: CONTINUED

VARIABLES	Eq.1	Eq.2	Eq.3	Eq.4	Eq.5	Eq.6	Eq.7	Eq.8
SES VARIABLES:								
MOTHER'S								
Educt. <second.	–.202 (.007)	—	—	—	–.076 (.204)	–.083 (.187)	–.097 (.147)	–.072 (.220)
LATRINE								
No latrine		–.313 (.002)	—	—	–.200 (.044)	–.201 (.043)	–.196 (.048)	–.173 (.070)
FATHER'S OCC.								
Non Civil/Army			–.249 (.001)	—	–.144 (.057)	–.162 (.042)	–.179 (.026)	–.122 (.096)
EXPENDITURES								
Log in Rp.				.099 (.005)	.058 (.076)	.060 (.069)	.054 (.089)	.032 (.221)
MACRO VAR.								
Health Program						–.186 (.214)	—	—
Family Planning							–.767 (.000)	–.998 (.000)
Regional Development								.292 (.002)
LR Null Model	6852	6852	6852	6852	6852	6852	6852	6852
LR Model	6772	6771	6770	6771	6766	6766	6761	6757
AIC with $\beta = 0$	169.5	171.8	173.2	170.4	180.5	181.2	191.6	199.6
No. of cases	4715	4715	4715	4715	4715	4715	4715	4715

†*Note: Four intercept parameters are not presented in the table. P values within parenthesis. The coefficients of each categorial variable represent a contrast with deleted categories.*

Intervention Effects at The Macro Levels and SES Adjusted for Biologic Factors

Table 8.8 (*page 292*) shows that children who are living in the PHC-CA who have a strong health or family planning program are more likely to have a better health status involving weight–for–height. Similarly, children whose mother's education are at least secondary school have a higher probability of having a better health status compared with other children. Children whose father's occupation is a *pegawai negeri* or ABRI have also show a better health status compared with other

Table 8.7: PARAMETER ESTIMATES OF INTERVENTION EFFECTS ON THE INDEX OF HEALTH STATUS INVOLVING WEIGHT–FOR–HEIGHT ADJUSTED FOR BIOLOGICAL FACTORS† USING A PROPORTIONAL ODDS MODEL FOR ORDINAL DATA

VARIABLES	Eq.1	Eq.2	Eq.3	Eq.4	Eq.5	Eq.6	Eq.7	Eq.8
BIOLOGIC MOTHER'S:								
Age at birth	–.023 (.000)	–.023 (.000)	–.023 (.000)	–.023 (.000)	–.023 (.000)	–.023 (.000)	–.024 (.000)	–.023 (.004)
CHILD'S AGE								
In Log Month	.214 (.000)	.187 (.000)	.214 (.000)	.217 (.000)	.211 (.000)	.216 (.000)	.296 (.000)	.272 (.000)
CHILD'S								
Birth order	.133 (.000)	.134 (.000)	.134 (.000)	.122 (.001)	.135 (.000)	.135 (.000)	.129 (.000)	.126 (.001)
(Birth order)^2	–.009 (.006)	–.009 (.006)	–.009 (.006)	–.009 (.013)	–.010 (.005)	–.010 (.005)	–.009 (.010)	–.008 (.013)
HEALTH INTERVENTIONS								
UPGK:								
Nonparticipant		– .222 (.000)	—	—	—	—	—	–.178 (.003)
ORT								
No Oralit			–.059 (.302)	—	—	—	—	–.009 (.468)
IMMUNIZATION								
Not completed				–.101 (.077)	—	—	—	–.049 (.249)
FAM. PLANNING								
Never used					–.103 (.118)	—	—	–.012 (.449)
TT at ANC								
Never had TT						–.132 (.021)	—	–.082 (.116)
BREASTFEEDING								
Had stopped							–.313 (.000)	–.294 (.000)
LR Null Model	5016	5016	5016	5016	5016	5016	5016	5016
LR Model	4977	4970	4976	4976	4976	4974	4966	4959
AIC with $\beta = 0$	86.1	98.7	86.3	88.1	87.5	90.2	107.7	120.3
No. of cases	4715	4715	4715	4715	4715	4715	4715	4715

†*Note: Four intercept parameters are not presented in the table. P values within parenthesis. The coefficients of each categorial variable represent a contrast with deleted categories.*

Table 8.8: PARAMETER ESTIMATES OF INTERVENTION EFFECTS AT THE MACRO LEVEL ON THE INDEX HEALTH STATUS INVOLVING WEIGHT–FOR–HEIGHT ADJUSTED FOR BIOLOGICAL FACTORS† USING A PROPORTIONAL ODDS MODEL FOR ORDINAL DATA

VARIABLES	Eq.1	Eq.2	Eq.3	Eq.4	Eq.5	Eq.6	Eq.7	Eq.8
BIOLOGIC MOTHER'S:								
Age at birth	–.022 (.000)	–.023 (.000)	–.023 (.000)	–.023 (.000)	–.023 (.000)	–.022 (.000)	–.021 (.000)	–.023 (.000)
CHILD'S AGE								
In Log Month	.216 (.000)	.214 (.000)	.214 (.000)	.213 (.000)	.214 (.000)	.214 (.000)	.210 (.000)	.214 (.000)
CHILD'S								
Birth order	.138 (.000)	.133 (.000)	.133 (.000)	.133 (.000)	.134 (.000)	.132 (.000)	.128 (.001)	.132 (.001)
(Birth order)^2	– .010 (.003)	–.009 (.006)	–.009 (.006)	–.009 (.006)	–.009 (.006)	–.009 (.006)	–.009 (.009)	.009 (.006)
SES VARIABLES MOTHER'S								
Educt. <second.	–.281 (.001)	—	—	—	—	—	—	—
Never Heard immunization		–.092 (.054)	—	—	—	—	—	—
LATRINE								
No latrine			–.049 (.328)	—	—	—	—	—
FATHER'S OCC.								
Non Civil/Army				–.175 (.018)	—	—	—	—
EXPENDITURES								
Log in Rp.					–.026 (.256)	—	—	—
MACRO VAR.								
Health Program						.499 (.012)	—	—
Family Planning							1.482 (.000)	—
Regional Development								.014 (.454)
Availability Services								.026 (.175)
LR Null Model	5016	5016	5016	5016	5016	5016	5016	5016
LR Model	4971	4975	4976	4974	4976	4974	4959	4976
AIC with $\beta = 0$	96.5	88.6	86.3	90.5	86.5	91.1	121.8	86.9
No. of cases	4715	4715	4715	4715	4715	4715	4715	4715

†*Note: Four intercept parameters are not presented in the table. P values within parenthesis.*
The coefficients of each categorial variable represent a contrast with deleted categories.

children. There is no evidence from this table that the availability of health services and regional development determine the level of health status involving weight–for–age.

Intervention Effects Adjusted for Biologic, The Micro and Macro Variables

Table 8.9 (*page 294–295*) shows that intervention effects have been adjusted for the micro and macro variables simultaneously. At the micro level, none of the intervention variables has an independent effect to child health status involving weight–for–height.

An independent effect of family planning program can been seen in equation 8. This effect is relatively higher in equation 8 compared with equation 7, where equation 8 has not taken the regional development into account in the model. This suggests that family planing associations are confounded by regional development. Indeed, a PHC area with better regional development may have a better family planning program. [3]

8.4 MODEL COMPARISONS

These model comparisons have two different objectives. The first objective is to examine the consistency of RR estimates of intervention and SES variables on the three different indices of health status (*dependent variables*). For example, is there any difference in size or magnitude of risk for having low health status among children who never participated in UPGK, regardless whether the dependent variable was derived using data on the weight–for–age, height–for–age, or weight–for–height. In this case we use the same statistical technique,

[3]We examined all possible interactions between macro variables, but there is no significant interaction–term found. Results are not shown in the table.

Table 8.9: PARAMETER ESTIMATES OF INTERVENTION EFFECTS ON THE INDEX OF HEALTH STATUS INVOLVING WEIGHT–FOR–HEIGHT ADJUSTED FOR BIOLOGICAL, SES, MACRO VARIABLES† USING A PROPORTIONAL ODDS MODEL FOR ORDINAL DATA

VARIABLES	Eq.1	Eq.2	Eq.3	Eq.4	Eq.5	Eq.6	Eq.7	Eq.8
BIOLOGIC MOTHER'S:								
Age at birth	–.023 (.000)	–.024 (.000)	–.024 (.000)	–.024 (.000)	–.023 (.000)	–.023 (.000)	–.022 (.000)	–.022 (.000)
CHILD'S AGE								
In Log Month	.277	.272	.273	.271	.276	.277	.267	.266
	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
CHILD'S								
Birth order	.128 (.001)	.125 (.001)	.125 (.001)	.127 (.001)	.130 (.001)	.130 (.001)	.129 (.001)	.132 (.001)
(Birth order)^2	– .009 (.013)	–.008 (.014)	–.008 (.014)	–.008 (.013)	–.008 (.014)	–.008 (.014)	–.008 (.016)	–.008 (.014)
HEALTH INTERVENTIONS								
UPGK:								
Nonparticipant	– .172 (.004)	–.178 (.003)	–.175 (.004)	–.179 (.003)	–.170 (.005)	–.165 (.006)	–.165 (.006)	–.161 (.108)
ORT								
No Oralit	.047 (.345)	.001 (.497)	.027 (.406)	.000 (.499)	.033 (.388)	.029 (.400)	.002 (.494)	.007 (.475)
IMMUNIZATION								
Not completed	– .051 (.240)	–.052 (.237)	–.048 (.251)	–.050 (.245)	–.058 (.213)	–.058 (.212)	–.021 (.383)	–.014 (.427)
FAM. PLANNING								
Never used	.022 (.406)	.020 (.412)	.006 (.475)	.017 (.426)	.014 (.439)	.025 (.394)	.043 (.322)	.030 (.372)
TT at ANC								
Never had TT	–.048 (.246)	–.092 (.094)	–.058 (.203)	–.092 (.091)	–.060 (.197)	–.051 (.238)	–.027 (.355)	–.038 (.297)
BREASTFEEDING								
Had stopped	–.300 (.000)	–.293 (.000)	–.298 (.000)	–.292 (.000)	–.297 (.000)	–.296 (.000)	–.274 (.000)	–.268 (.002)
Continued on next page								

Table 8.9: CONTINUED

VARIABLES	Eq.1	Eq.2	Eq.3	Eq.4	Eq.5	Eq.6	Eq.7	Eq.8
SES VARIABLES:								
MOTHER'S								
Educt. <second.	–.257 (.003)	—	—	—	–.286 (.003)	–.278 (.003)	–.253 (.007)	–.281 (.003)
LATRINE								
No latrine		–.103 (.185)	—	—	–.206 (.047)	–.207 (.046)	–.195 (.057)	–.167 (.087)
FATHER'S OCC.								
Non Civil/Army			–.140 (.055)	—	–.122 (.111)	–.103 (.156)	–.067 (.252)	–.125 (.110)
EXPENDITURES								
Log in Rp.				–.042 (.154)	–.072 (.050)	–.075 (.043)	–.069 (.056)	–.045 (.151)
MACRO VAR.								
Health Program						.209 (.205)	—	—
Family Planning							1.208 (.000)	1.467 (.000)
Regional Development								–.321 (.001)
LR Null Model	5016	5016	5016	5016	5016	5016	5016	5016
LR Model	4955	4959	4958	4959	4952	4952	4940	4951
AIC with $\beta = 0$	128.2	121.0	122.9	121.3	134.7	135.4	158.3	137.2
No. of cases	4715	4715	4715	4715	4715	4715	4715	4715

†*Note: Four intercept parameters are not presented in the table. P values within parenthesis. The coefficients of each categorial variable represent a contrast with deleted categories.*

namely the generalized linear model for ordinal data (*a proportional odd model*) applied in this chapter. The second objective has a similar goal as the first objective, but we considered two other dependent variables, namely survival and nutritional status. In this case, relative risk of death was estimated according to a proportional hazard regression model for grouped data, which was presented in chapter 7. The risk of growth faltering was derived from a proportional odds model, which was presented in chapter 8.

To reduce complexity of model comparisons, we only considered five intervention variables (*UPGK, ORT, immunization, contraceptive use, and TT at ANC*) and three SES variables (*mother's education, availability of latrine facility and father's occupation*). Furthermore, models were only adjusted for the effects of biologic factors. For relative risks derived from survival analysis, mother's age at the time of childbirth, birth order, and a quadratic term of birth order are used as adjustment factors. In addition to these control variables, for the risk of growth faltering and low health status, we also considered child's age (*in a logarithm scale*) as an adjustment factor. It should be noted that a main concern of this comparison is to obtain a reliable result using empirical data, and not the mechanisms by which determinants affect outcomes. The mechanisms have been examined in the previous analyses.

8.4.1 Comparability of Models Between Three Indices

Table 8.10 (*page 297*) shows RR estimates of intervention and SES variables on three different indices of health status. All relative risks are derived from models that have been adjusted for biologic factors. Numbers presented within parentheses are estimated values of lower and upper 95 percent confidence intervals. Using these confidence intervals and a point estimate of relative risks, one can judge the importance of each variable from a practical point of view. If the range of confidence interval includes unity (*one*), then one should not consider the risk factor to have a practical interpretation. Even when RR has values greater than one, the population impact is obviously determined by the prevalence of risk factor in the community. In this case, an attributable risk may be derived from the size of RR and a

Table 8.10: ODDS RATIOS AND 95% CONFIDENCE INTERVALS† ON THE INDEX OF HEALTH STATUS, WHICH INVOLVES WEIGHT–FOR–AGE, HEIGHT–FOR AGE, AND WEIGHT–FOR–HEIGHT ON PROXIMATE DETERMINANT AND SES VARIABLES‡

INTERVENTION and SES VARIABLES	Relative Risks and 95% Confidence Intervals		
	Weight–for–Age	Height–for–Age	Weight–for–Height
HEALTH INTERVENTION			
UPGK			
Nonparticipant	1.4 (1.23−1.58)	1.4 (1.26−1.58)	1.3 (1.10−1.41)
ORT			
No. Oralit	1.2 (0.94−1.50)	1.1 (0.91−1.39)	1.1 (0.85−1.33)
IMMUNIZATION			
Not completed	1.2 (1.03−1.37)	1.2 (1.04−1.35)	1.1 (0.96−1.27)
FAM. PLANNING			
Never used	1.2 (1.04−1.50)	1.2 (1.00−1.38)	1.1 (0.94−1.31)
TT at ANC			
Never had ANC	1.2 (1.02−1.32)	1.0 (0.91−1.06)	0.9 (0.81−0.94)
SES FACTORS			
MOTHER'S EDUC.			
Less than Secondary	1.5 (1.24−1.75)	1.3 (1.10−1.51)	1.3 (1.12−1.57)
LATRINE			
No latrine	1.3 (1.04−1.64)	1.4 (1.18−1.77)	1.0 (0.77−1.18)
FATHER'S OCCUP.			
Non Civil/Army	1.5 (1.24−1.71)	1.3 (1.15−1.55)	1.2 (1.01−−1.40)

†Note: Within parenthesis.
‡All estimates of RR are adjusted for biologic factors.

prevalence rate for the risk factor in the population.

Relative risks associated with intervention and SES variables vary according to the dependent variable considered. Let the dependent variable be the index of health status, which was derived from child weight–for–age data (*Table 8.10 column 2*). Except ORT, all other variables show higher risks of nonusers intervention compared to their reference categories. Similarly, children whose mother's education is below secondary school, who have no access to a flush latrine facility, or whose father's occupation is not *pegawai negeri* or army, show higher risks compared with their reference categories. These relative risks are also significantly different from the unity (*confidence intervals exclude unity*). In contrast with the index of health status derived from height–for–age (*column 3*), three intervention variables show no increase risks. These variables are ORT, contraceptive use, and TT at ANC. But relative risks associated with all SES variables are statistically different from the unity. For the dependent variable that involves weight–for–height (*column 4*), only three out of eight variables show increased risks. These variables are UPGK, mother's education, and father's occupation.

This finding suggests that the index of health status that involves weight–for–age can be linked to both intervention and SES variables. Although similar relative risks for SES variables are found with the index of health status that involves height–for–age, this index of health status is less closely associated with the intervention variables. This finding also suggests that the index of health status that involves weight–for–height is poorly associated with intervention variables and only weakly associated with SES variables.

8.4.2 Health Status Using Weight–for–Age

Table 8.11 (*page 300*) shows estimates of relative risks using child survival status, growth faltering and the index of health status as dependent variables. Here the index of health status and growth faltering used children weight–for–age data. None of the intervention variables is directly associated with growth faltering. However, UPGK, child immunization status, and ever used contraception variables can be linked with survival status. Although stated in chapter 6 that ORT and TT at ANC were not associated with survival status of children under 5 years, it should be noted that TT at ANC could be linked with infant mortality. Except a latrine facility, SES variables can be linked with child survival status. All SES variables can be directly associated with the nutritional status indicators.

If the index of health status can combine determinants on mortality and growth faltering, the index of health status is expected to capture all determinants associated with both mortality and growth faltering as the dependent variables. On the other hand, if a certain variable is not proved as the determinant on either mortality or growth faltering, it should not become a determinant for the index of health status. Furthermore, it is probable that if a certain factor is weakly linked with either mortality or growth faltering indicator, their combined effect on health status may show a nonimportant association. But when the effect of a certain determinant on either mortality or growth faltering is considered to be very strong, we should expect that this factor can be linked with the index of health status.

Using this logic, findings clearly suggest that the index of health status based on weight–for–age performs according to our expectation, except for the TT at ANC. Here the relative risk associated with TT

Table 8.11: COMPARISON OF RELATIVE RISKS AND THEIR 95% CONFIDENCE INTERVALS† ACCORDING SURVIVAL ANALYSIS, NUTRITIONAL STATUS AND THE INDEX OF HEALTH STATUS, WHICH INVOLVES WEIGHT–FOR–AGE ON INTERVENTION AND SES VARIABLES‡

INTERVENTION and SES VARIABLES	Relative Risks and 95% Confidence Intervals		
	Child Survival Status	Child Growth Faltering	Child Health Status
HEALTH INTERVENTION			
UPGK			
Nonparticipant	7.3 (5.52−9.74)	1.1 (0.92−1.21)	1.4 (1.23−1.58)
ORT			
No. Oralit	1.0 (0.62−1.71)	1.2 (0.92−1.53)	1.2 (0.94−1.50)
IMMUNIZATION			
Not completed	7.5 (3.11−18.25)	1.0 (0.88−1.20)	1.2 (1.03−1.37)
FAM. PLANNING			
Never used	1.5 (1.04−2.09)	1.1 (0.94−1.36)	1.2 (1.04−1.50)
TT at ANC			
Never had ANC	1.1 (0.83−1.47)	1.1 (0.97−1.29)	1.2 (1.02−1.32)
SES FACTORS			
MOTHER'S EDUC.			
Less than Secondary	1.8 (1.10−2.82)	1.4 (1.15−1.67)	1.5 (1.24−1.75)
LATRINE			
No latrine	1.2 (0.72−2.04)	1.3 (1.04−1.71)	1.3 (1.04−1.64)
FATHER'S OCCUP.			
Non Civil/Army	1.7 (1.08−2.54)	1.4 (1.21−1.73)	1.5 (1.24−1.71)

†Note: Within parenthesis.
‡All estimates of RR are adjusted for biologic factors.

at ANC for either mortality or growth faltering was not significantly different from unity, but the combined effect suggests otherwise. It should be noted however that both point estimates of relative risks were greater than unity (*1.1*) and their combined effect is only 1.2. One may also notice that TT at ANC was stated as an important determinant for infant mortality in the survival analysis, while the ANC variable was shown to be an important determinant for mortality according to both an indirect estimate and the regression analysis on mortality index (*MI*).

8.4.3 Health Status Using Height–for–Age

Table 8.12 (*page 302*) shows similar numbers as the index health status, which was based on children height–for–age data. In general, the index of health status that involves height–for–age performs, as expected. Here relative risk associated with TT at ANC shows consistent lack of association as expected. Clearly this table also shows that the index of health status derived from height–for–age can represent a combination effect (*average*) from mortality and nutritional status alone.

8.4.4 Health Status Using Weight–for–Height

In contrast with the two previous tables, Table 8.13 (*page 303*) does not show a superiority of the index of health status that involves weight–for–height compared with the other two indices. There are two important reasons for the disadvantage of this index. First, none of the intervention and SES variables were independently associated with the nutritional status indicator (*wasting*). Second, the relative risk for the health status index is not able to capture an important de-

Table 8.12: COMPARISON OF RELATIVE RISKS AND THEIR 95% CONFIDENCE INTERVALS† ACCORDING SURVIVAL ANALYSIS, NUTRITIONAL STATUS AND THE INDEX OF HEALTH STATUS, WHICH INVOLVES HEIGHT–FOR–AGE ON INTERVENTION AND SES VARIABLES‡

INTERVENTION and SES VARIABLES	Relative Risks and 95% Confidence Intervals		
	Child Survival Status	Child Growth Faltering	Child Health Status
HEALTH INTERVENTION			
UPGK			
Nonparticipant	7.3 (5.52−9.74)	1.2 (0.99−1.27)	1.4 (1.26−1.58)
ORT			
No. Oralit	1.0 (0.62−1.71)	1.1 (0.90−1.39)	1.1 (0.91−1.39)
IMMUNIZATION			
Not completed	7.5 (3.11−18.25)	1.1 (0.92−1.21)	1.2 (1.04−1.35)
FAM. PLANNING			
Never used	1.5 (1.04−2.09)	1.1 (0.89−1.25)	1.2 (1.00−1.38)
TT at ANC			
Never had ANC	1.1 (0.83−1.47)	1.0 (0.95−1.22)	1.0 (0.91−1.06)
SES FACTORS			
MOTHER'S EDUC.			
Less than Secondary	1.8 (1.10−2.82)	1.2 (1.01−1.40)	1.3 (1.10−1.51)
LATRINE			
No latrine	1.2 (0.72−2.04)	1.5 (1.17−1.82)	1.4 (1.18−1.77)
FATHER'S OCCUP.			
Non Civil/Army	1.7 (1.08−2.54)	1.3 (1.09−1.50)	1.3 (1.15−1.55)

†Note: Within parenthesis.

‡All estimates of RR are adjusted for biologic factors.

Table 8.13: COMPARISON OF RELATIVE RISKS AND THEIR 95% CONFIDENCE INTERVALS† ACCORDING SURVIVAL ANALYSIS, NUTRITIONAL STATUS AND THE INDEX OF HEALTH STATUS, WHICH INVOLVES WEIGHT–FOR–HEIGHT ON INTERVENTION AND SES VARIABLES‡

INTERVENTION and SES VARIABLES	Relative Risks and 95% Confidence Intervals		
	Child Survival Status	Child Growth Faltering	Child Health Status
HEALTH INTERVENTION			
UPGK			
Nonparticipant	7.3 (5.52−9.74)	1.0 (0.83−1.08)	1.3 (1.10−1.41)
ORT			
No. Oralit	1.0 (0.62−1.71)	1.0 (1.00−1.02)	1.1 (0.85−1.33)
IMMUNIZATION			
Not completed	7.5 (3.11−18.25)	1.0 (0.83−1.11)	1.1 (0.96−1.27)
FAM. PLANNING			
Never used	1.5 (1.04−2.09)	1.0 (0.83−1.16)	1.1 (0.94−1.31)
TT at ANC			
Never had ANC	1.1 (0.83−1.47)	1.1 (0.96−1.25)	0.9 (0.81−0.94)
SES FACTORS			
MOTHER'S EDUC.			
Less than Secondary	1.8 (1.10−2.82)	1.2 (1.00−1.43)	1.3 (1.12−1.57)
LATRINE			
No latrine	1.2 (0.72−2.04)	0.9 (0.72−1.13)	1.0 (0.77−1.18)
FATHER'S OCCUP.			
Non Civil/Army	1.7 (1.08−2.54)	1.1 (0.94−1.32)	1.2 (1.01−1.40)

†Note: Within parenthesis.
‡All estimates of RR are adjusted for biologic factors.

terminant on mortality, except for UPGK. For example, relative risks associated with immunization and contraceptive use show strong association with mortality, but show no significant associations with the index of health status derived from weight–for–height. Thus compared with the two other child health status indicators, this index would be less preferable.

8.5 SUMMARY OF THE INDEX OF HEALTH STATUS

Associations on determinants of child health status can be stronger or weaker than associations on determinants of mortality or growth faltering alone. If an explanatory variable is strongly associated with either mortality or nutritional status, this variable is more likely to determine the level of child health status. But when the associations between the explanatory variable and both mortality and growth faltering are very weak, there is no association found in the determinant of child health status. In general, the association between an explanatory variable and the index of health status represents an average of two figures, which are previously shown by survival and nutritional status models.

UPGK and immunization may improve child health status that used weight–for–age. Probable effects of UPGK are associated with increased utilization of immunization, contraceptive use, TT at ANC, and ORT. However, effect of family planning on health status index involving weight–for–age may not necessarily exist through the improvement on a contraceptive use, but it may operate indirectly through other variables not in our models.

Mother's education and father's occupation still have independent effects on the index of health status, although as do income, availability of latrine, and regional development variables, these factors affect the index of health status through intervention variables. There is also a consistent finding that availability of government health services is not an important determinant for the index of health status.

The strong association between strength of family planning program and stunting was carried over in the index of health status involving height–for–age. Similarly, a regional development also has an independent effect on the child health status indicator. On the other hand, even though immunization status and UPGK were not associated with stunting, because of their strong association with mortality these interventions can be associated with the level of child health status. Obviously, the degree of association is substantially reduced.

Compared with the other two indices, the index of health status that uses weight–for–height shows a less strong association with child survival interventions and socioeconomic level of the family. Only family planning program at the PHC level shows a similar association as the index from weight–for–age. Data also show that this family planning program is strongly confounded by a regional development indicator, which suggests that the effect of family planning program is stronger in less developed areas compared with more developed areas (*coefficient of development indicator reverses to negative*).

Although all indices of health status can represent a combination effect (*average*) from mortality and three different nutritional status indicators, the index that involves weight–for–age performs better compared with the other two indicators. Indeed, the index of health status that uses weight–for–height data seems not to be an appropriate indicator, since it cannot capture average effects of determinants on mortality and nutritional status. Data also suggest that the index of health status that involves height–for–age is strongly affected by components of nutritional status indicators.

Chapter 9

DISCUSSION AND CONCLUDING REMARKS

9.1 SUMMARY OF IMPACT EVALUATION

The results of this study provide the first empirical evidence for the impact assessment of specific child survival interventions using an index of health status that combines mortality and nutritional status as an outcome. The impact of child survival interventions on health appears to arise primarily from the protection of children from death. At the same time, socioeconomic characteristics of the households affect child health primarily through the reduction of growth faltering.

In contrast with the impact of child survival interventions on mortality, socioeconomic factors did not affect nutritional status through the utilization of UPGK, ORT, immunization, and family planning programs. Socioeconomic factors may affect nutritional status through the availability of food and the use of a curative treatment. Unfortunately, these two proximate determinants are not examined in this study. Nevertheless, the data show strong evidence that the determinants of mortality did not necessarily act as determinants of nutritional status.

Impact assessments of child survival programs usually focus on the children who have died and the health status of children who are still alive. However, the importance of determinants should be based on their overall impact on mortality and on the health status of survivors. This can be achieved by creating a new index of health status, which is introduced in this study.

Because index of health status is considered an ordinal–scale measure, the proportional odds model is an appropriate choice. Using this model, the magnitude of the effects of determinants can be summarized in relative risk estimates, which are commonly used in the epidemiological studies. By creating a new index, we expect that one should obtain a relative risk (RR) of a certain variable on the index of health status that represents an average of risks on mortality and growth faltering. Our study shows that an index of health status combining nutrition and mortality can meet such a requirement. However, the determinants of this index of health status will depend on the nutritional indicator selected, whether weight–for–age, height–for–age, or weight–for–height.

Among the three indices tested, the index that involves weight–for–age is considered the best. Besides it represents an average of risks on mortality and growth faltering, the consistancy of findings across analyses were shown using this index. Furthermore, the practical implication on the data collection will have many advantages compare with two other indices.

The second choice would be the index of health status using height–for–age. However, because the nutritional status indicator would strongly affect this index of health status, the significance effect of intervention on mortality may become nonsignificant for the index of health status due to insignificance effect of intervention on growth faltering. For example, one may find it difficult to accept that increasing of family planning at the aggregate level will decrease the health status. This result is due to the strong association between family planning program with increasing prevalence of stunting.

The index that involves weight–for–height data is unsatisfactory. There are many inconsistent results in the analyses using this outcome. More importantly, because the prevalence rate of wasting in the population is relatively low, it affects the precision of relative risk estimate. The relative risks associated with various interventions have wider confidence intervals compared with relative risks from other two indices.

From program and measurement points of view, the index of health status that involves weight–for–age has many advantages as compared with other two other indices. First, measuring weight–for–age of children has already been accepted by mothers as a monitoring tools of child health. Second, an indicator based on weight–for–age has been widely used to measure nutritional status of populations (*Dowler, 1982; Ross and Vaughan, 1984; WHO, 1986*). Third, the index of health status that involves weight–for–age shows more consistent determinants compared with other two indices.

9.1.1 Impact of UPGK (Growth Monitoring)

Despite much criticism about growth monitoring programs (*Cape, 1988, 1988; Gerein, 1988; Henry et al., 1989; Nabarro and Chinnock, 1988*), this study shows that growth monitoring can improve child health. The improvement in health is mainly through a reduced risk of death, since growth monitoring was not be associated with improved nutritional status. Other studies in Indonesia also suggest that growth monitoring did not improve the nutritional status of the children (*Priyosusilo, 1988*).

The impact of growth monitoring is more likely to be indirect, through an increase in utilization of modern health services and improvement of other health behaviors. Our data show that UPGK can improve utilization of immunization, ORT, and contraceptive use. However, given that contraceptive users may have a social organization that runs UPGK (*Achadi, 1990*), then contraceptive use may possibly increase the adoption of UPGK. In other words, with this survey data, we cannot determine the direction of causation between UPGK and contraceptive use.

UPGK may increase the utilization of curative treatments. Since providers of UPGK are either health volunteers (*kader sehat*) or PHC staff, then mothers whose children have a serious illness may well know the place of health providers for their children. We did not examine the association between UPGK and mothers' behaviors toward curative treatments since such data are not available. However, the independent effect of UPGK after adjustment for ORT, immunization, ANC, and contraceptive use suggests that such an association is probable. There may also be a selection bias in that mothers who have adopted UPGK, may have better health knowledge and behaviors regarding child care that reduces the risk of death.

Vitamin A supplement are distributed through UPGK to children under–5 years old. The effect of vitamin A supplementation on child survival has been reported from other areas in Indonesia (*Sommer, et al., 1986; Muhilal et al., 1988*), therefore the improved survival may also be attributed to vitamin A supplementation. Unfortunately, the growth card did not show a complete record of the vitamin A distribution, so that we cannot examine this association in detail.

The absence of an association between UPGK and nutritional status can be explained in the following way. First, nutritional status is not only determined by illness, but it also determined by food intake and household resources (*Habicht and Butz, 1979*). Children who are better off in terms of socioeconomic levels (*i.e., mother is more educated and high family income*) show a better nutritional status compared with other children, because they have better feeding practices and food resources. Second, the data also suggest that mother's education, household's income, and father's occupation reduce risk of death through the utilization of preventive health services in places where these factors are also associated with the utilization of curative health services. Thus reduction of prevalence of underweight and wasting are may be associated with better utilization of curative health services.

Because some child survival interventions can prevent fatalities directly, it is likely that many surviving children will show stunting. The reason is that children who have high risk of death generally experience chronic illness (*Mata et al., 1972*). If these children do not die, then they will survive but probably have stunted growth.

At the aggregate level, our data indicate that an increase on utilization of child survival interventions is likely to increase the prevalence of stunting. This result is also confirmed by the fact that in some countries where mortality is declining very fast, the prevalence of stunting among survivors is relatively high compared with countries where mortality remains relatively high. For example, Sri Lanka has had a rapid mortality decline in recent years and the prevalence of stunting is high (*DHS, 1988*). Indeed, Indonesian data suggests a patten similar to Sri Lanka (*Government of RI and UNICEF, 1989*).

Although UPGK improves child survival substantially, the effect of UPGK on mortality is likely to be overestimated. The possibility of "recall" and "selection " biases associated with this intervention cannot be ruled out. "A recall bias" is more likely to occur when children have died a few years preceding the survey date. Respondents cannot remember the correct answer, and they may tend to answer that their dead children had never been brought to the weighing program. This tendency will increase the estimate of relative risks. However, an opposite answer is also possible, since women may be embarrassed if their children had never been brought to a weighing program.

"A selection bias" may occur for two reasons. First, mothers may refuse to participate in a UPGK program because their children have poor nutritional status and they were embarrassed by their child's nutritional status. Second, if the UPGK program was started in a recent years, then child deaths that occurred before the UPGK was introduced will increase the estimate of relative risk; surviving children of the same birth cohort will have a greater chance to participate in UPGK than the nonsurvivors. However, since in our study area UPGK had been introduced more than 5 years before the survey, this "selection bias" should not be of concern.

If children died before the age of one–month (*children younger than one month are usually not allowed to be weighed in UPGK*), then this can also result in an overestimate of relative risk. We tried to examine the effect of birth cohort in the model and also to consider survival analysis for children who survive at least 2 months or even one year. But these analyses did not yield different conclusions. Only a small fraction of relative risk is reduced, which suggests that UPGK may truly be associated with improved survival.

Because the prevalence of exposure to UPGK is relatively high (*64 percent*), the population impact of UPGK will be very substantial. The prevalence of UPGK participation suggests that the accessibility of the program is very high. There should be almost no sociological, psychological, and physical barriers to the acceptability of a UPGK program, since the program is designed by the women in the community for their own children (*Priyosusilo, 1988*). The major issue for the health provider is: how to improve the growth monitoring activity, which in fact is not strictly a monitoring of child growth but also includes curative and prevention actions (*Taylor, 1988*). These actions should not be limited to medical interventions, but should also include some social modifications, such as health education and social–networking through community organizations. It is expected that social modifications should optimize the utilization of health resources available in the area.

9.1.2 Impact of ORT Program

We use availability of ORS packets (*Oralit*) at home as a proxy for an ORT program in this study. Further we assumed that if ORS is available at home, then the household was covered by an ORT program. As explained in the previous chapter, the ORT program may also promote the sugar–salt–solutions that can be made at home. However, our interest is not in the biological effect of ORS but in whether there were any different outcomes among households exposed to an ORT program compared with non-exposed households. More specifically, this variable is a proxy for how extensively the ORT program had been delivered and accepted by the community.

The ORT program in this study area is considered very weak.

Only 4 percent of all households have Oralit (*ORS*) at home, so that only about 6 percent of the total of children under–5 had access to Oralit (*ORS*). However, when compared to data collected in 1983 from other areas outside Java Island, this prevalence could be considered as high: the prevalence of households having ORS in the 1983 study was about 2 percent (*Winardi, 1984*). Since there is no evidence that ORT had an independent effect on any outcome, it is unlikely that ORT has a meaningful health impact in this area.

It important to note that an ORT program is a curative action that is different from preventive actions such as a vaccination program. Although the effectiveness of ORT programs in many areas have been suggested (*Bennet et al., 1990*), without any other improvements in environmental sanitation, such as water supply, saving children from one diarrhea attack does not eliminate or reduce a future attack from the disease (*Taylor and Greenough, 1989*).

9.1.3 Immunization

We examined immunization programs for neonatal tetanus, tuberculosis, diphtheria, and polio. Based on these retrospective histories, the data showed that immunization can reduce mortality risks but not the risk of growth faltering.

There are two important findings from this study that should be noted. First, it cannot be assumed that the impact of immunization is an independent effect resulting from the biological–efficacy of vaccines. There is a strong indication that immunization status captures other risk factors excluded by this study. For example, it is probable that children who ever had been given immunization may have received better medical treatment and care during severe illness, compared with nonimmunized children. However, because treatments during illness were not included in the analyses, we cannot be sure that these factors operated together. Furthermore, our data suggest that mortality risk associated with incomplete immunization (*TT, DPT, and polio*) was not heavily dependent on child's age. For example, the estimate of relative risk of immunization status at the age of less than one year did not show a significant difference from the estimates of relative risk based on children aged 1 to 5 years. This suggests that a selection bias is partly responsible in such apparent associations. Namely, children who received immunization are likely to be very select group that are better off in terms of other preventive/curative controls (*only about 15 percent of total children*).

Second, the effects of maternal TT immunization can be seen only under age one year. This effect is biologically plausible for tetanus toxoid since this vaccine can affect only perinatal death (*Foster, 1984; Ross, 1986*). Unless there is some selectivity for using TT, which is confounded with the utilization of other preventive or curative measures, children saved from a tetanus neonatal should face the same of risk factors as other children (*non-vaccinated for TT*); however, the selectivity of mothers who receive TT cannot be ruled out in this study. Analyses on the associations between TT given at ANC and other mortality risks showed that effects of TT on under–5 mortality are confounded by the utilization of other modern health services.[1]

To be effective, some vaccines have to be given more than one time (*Foster, 1984*). Consequently, "completed immunization" status is

[1]The term confounding refers to the effect of an extraneous variable that wholly or partially accounts for the apparent effect of the study exposure or that masks an underlying true association. A confounding variable should simultaneously satisfy two conditions: 1) it is a risk factor for study outcome, and 2) it is associated with the study exposure but it is not a consequences of exposure (*Schelesselman, 1982*).

defined as ever immunized with BCG plus 2 doses of DPT and polio. Referring to WHO's (*1982*) recommendation, children may be categorized as completely immunized only if their age is more than 10 weeks; children who die before age 10 weeks never have a chance to be completely immunized. This definition can still result in an overestimate of risk of death among nonimmunized children. Although one may consider a time–dependent covariate analysis (*Lawlles, 1982; Kalbfliesch and Prentice, 1980*) to handle this issue, because immunization is also a proxy for other variables, such a method may not have a real advantage. For example, even when the sample is limited to children who survived at least 12 months in the model, the result shows no change in the magnitude of association as compared with the analysis with the sample of all under 5. This suggest that the immunization effect may not only be attributed to the biological action of vaccines, but also to confounding on other preventive or curative controls.

Sources of bias that yield an underestimate of relative risk may come from overreporting on "completely immunized" among children who had died. Mothers may have felt embarrassed to declare the fact that their dead children were never immunized. As a result, an underestimate of relative risk emerges, since most of dead children would be reported as "completely immunized". However, this bias is less likely to occur in this study, since the estimate of relative risk of immunization is very large.

If an immunization program was significantly expanding in a recent years, then many deaths in the past would likely be nonimmunized; children who were born in the different birth cohorts would have different chances of being immunized. Our data suggest there was an expansion in the immunization program in this study area, but our exploratory analysis (*not shown*) that included a cohort time in the model did not change the parameter estimate of immunization in the model.

Despite the apparent impact of immunization on risk of death, less than 15 percent of children are completely immunized. This means that immunization is only about one–fourth as prevalent as UPGK. Given the same size of relative risks between the impact of immunization and of UPGK, the "attributable fraction" (*Schlesselman, 1982*) associated with immunization is smaller than UPGK. Furthermore, because these two risk are not mutually exclusive, one cannot assume that combination of UPGK and immunization intervention is the summation of these two effects.

9.1.4 Health and Family Planning Programs

In terms of service and distribution of contraception, family planning programs are integrated with PUSKESMAS (*PHC*) activities. Administratively, however, family planning programs are coordinated by the National Family Planning Coordinating Board (*FPNCB*). As part of POSYANDU activities, family planning services are conducted together with growth monitoring and curative and preventive services.

We found that the coverage of family planning program at the PHC level shows a strong effect on increased of child survival. However, because many children with a high risk of death can be saved, the number of surviving children with a past history of chronic illness is more likely to increase. One impact of increasing the number of children with chronic illness would be an increase in the number of stunted children. The data show an increase in the coverage of family planning program at PHC level is associated with an increase in the prevalence of stunted children.

As Bongaarts suggested (*1987, 1988*) that the improvements of child survival associated with family planning program may not be directly attributed to a more favorable distribution of births (*i.e., birth spacing, parity, and mother's age at birth*). Our data show that children whose mother is a nonuser of contraception are likely to have higher risk of death as compared with other children, but such an effect is dramatically reduced when utilization of other modern health services is considered simultaneously. This indicates that contraceptive users may either make better use of or have more access to modern health services, so that occasional acute illnesses can be kept from progressing ing to chronic illnesses. Moreover, if contraceptive use results in a smaller number of children in the household, the availability of food and health care for each child required will be correspondingly increase, compared to if there were no effect on number of children within household (*Potter, 1988a; 1988b; Trussell, 1988*). All of these effects will benefit children by increasing their chances to better nourished and nonstunted. Our data show that children living in the PHC areas with stronger family planning programs have substantially lower risks of becoming underweight or wasted compared with children living in PHC areas with weak family planning programs.

The apparent effects of family planning program may also be attributed to the selectivity of contraceptive users. The acceptability of family planning and health services are influenced by mother's education, husband's occupation, and total family income. Because contraceptive users are likely to be a selective group, they may also have better health knowledge and behaviors to prevent child death and to improve child nutritional status. These improvements are probably a result of an exposure to modern health services, which are obtained in clinics and UPGK program. The data suggest that when socioeconomic characteristics of households were included in the analysis, the effect of family planning program at the individual level was significantly reduced.

Although association between contraceptive use and child health status can be explained from its direct and indirect effects above, with the survey data one cannot be sure about the direction of causation. It is possible that because the PHC area has high mortality (*a poor area*), the distribution of family planning has been given special efforts, so that the utilization of family planning is higher compared with areas with lower mortality. This association was not suggested by this study. When the indicators of developments were examined together with family planning, the effect of family planning program was more powerful in the less developed areas. But there is no indication that poor PHC areas (*lower indicator of developments*) have higher utilization rates of the family planning program. Thus, one should not be concerned about the bias associated with selectivity of intervention in the poor areas.

9.1.5 Female Education

The effect of maternal education on child health status is limited to women whose education is secondary school or above. This may be associated with the fact that education below a secondary school level would not improve women's opportunities in many job markets. For example, one of the requirements to be a government worker is graduation from a secondary school or above. Even nomination as a community health worker is often based on the educational level being a secondary school or above. However, maternal education may be linked with the husband's occupation and household income. For example, highly educated women are more likely have a higher income or even be married to a husband with a certain occupation or education. So that household income and husband's occupation may act as confounding factors for maternal education.

This study shows that maternal education plays a significant role in the utilization of child survival interventions. The effects of maternal education at the aggregate level suggests that PHC areas with "highly educated" mothers tend to have a higher proportion of children who received child survival interventions. Furthermore, increasing average maternal education at the PHC level also increases the number of MWRA who had ever used contraception. At the same time, the increasing of maternal education can be linked with a decreased of prevalence of growth faltering in all forms.

There are many possible explanations why such associations are found in this study. A more educated society is more likely to have a higher participation and quality of social networks. With a better social organization may be an increase in the acceptability and efficiency of government health and family planning programs.

Following the government's plan, most health and family planning programs at the village level require community participation, particularly from women. Therefore women's organizations (*i.e., PKK*) play a significant role in UPGK or POSYANDU. If many women have a higher level education, the activity of such a social organization may be even more effective and efficient. One should not ignore the importance of health education which is a major component of the UPGK or POSYANDU programs in Indonesia. Health education will be more effective if the providers have a sufficient education.

It should be noted that the sustainability of community health program is influenced by community participation (*Rifkin, 1986*). If community participation is affected by maternal education at the aggregate level, one may underline the importance of maternal education as a key factor in the sustainability of village health programs.

Besides such possible associations, the aggregate level of maternal education may indicate the degree of modernization of the PHC area. It is possible, therefore, that an increased level of maternal education is simply an indicator of greater acceptability and accessibility of health service.

Multivariable analyses on the effect of maternal education show that highly educated women are more likely to have better child health status. The effect of maternal education on childhood mortality is mainly through an increased utilization of child survival interventions. However, the effect of maternal education on child growth faltering is not associated with an increased use of child survival interventions. The effect on growth faltering may be through the availability of food and curative treatments, which are not included in the study.

9.1.6 Income, Occupation, and Socioeconomic Development of the Region

The direct association between household income and health status is partially a result of an increase in purchasing power for health services. In this study area, the indirect costs of health service are still a significant factor, especially for family planning and curative health services (*Gani et al., 1989*). Although most child survival interventions can be obtained a relatively free of charge in the villages, this is limited to preventive services, such as immunization and vitamin–A supplementation. The data showed that most women received their contraceptive methods from a clinic (*PHC*), so that cost of transportation and travel time are important factors, even though pill, IUD, or even injection may be obtained at no cost in the clinic.

There is an indication that the utilization of modern health service is strongly affected by consumer demand. As example, although most curative and family planning services are provided at the PHC, the availability of services (*measured as a distance between village and PHC*) was not significantly associated with the utilization of child survival interventions. In fact, an income effect was not consistently found as a strong determinant for childhood mortality in all analyses. This implies that cost of health service is less important than individual's demand for seeking health services.

The strong association between income and nutritional status did not operate through the child survival interventions which are considered in our models. Two possible routes for income effects on nutritional status are an increase purchasing power for food and curative services. Increased for purchasing power to food affects nutritional status, since most households spend more than 65 percent of total expenditures on food. This indicates that even a small increase of income will likely affect food consumption in a significant way compared to situation where food consumption does not dominate expenditures.

An income effect on child nutritional status, may also operate through curative actions by the mother to avoid chronic sickness. For example, mothers with higher income may bring their child with measles to a PHC, this could reduce the severity of disease complications such as chronic cough or diarrhea. Unfortunately, this mechanism cannot be demonstrated by the thesis, since we did not collect such data. Nevertheless, higher income can be directly associated with overall nutritional status, which has been linked with a child morbidity experience (*Mata, Urrutia, and Lechtig, 1971*).

Father's occupation cannot be completely be separated from income effects. However, the data suggest that an independent effect of occupation as a government worker (*pegawai negeri*) or in the army (*ABRI*) exists both for mortality and nutritional status indicators. This independent effect may be linked with the following facts. First, a *pegawai negeri* has free health insurance that also covers his children. Second, most health and family planning programs are promoted through government institutions. In fact, on the whole many government workers probably actively participate in promoting programs for the community (*i.e., KB Safari*) (*Suyono, 1989; Molyneaux, et al., 1988; Warwick, 1986*). Third, all women whose husbands are a *pegawai negeri* or ABRI, are automatically registered as members of some government social organization (*DARMA WANITA or PKK*); these are is strongly encouraged to promote most government programs, including health and family planning programs. It should be noted that participation within these social organizations has an informal sanction, which may affect the husband's chances for job promotion. All of this may result in a positive impact on child health status. There are studies showing that social organizations and government workers (*i.e., village leaders*) play an important role on the success of family planning (*Warwick, 1986*) and growth monitoring programs in Indonesia (*Achadi, 1990*).

Regional development has been shown to be an important factor for determining child health status. The percentage of villages with an asphalt road in the PHC is used as an indicator for regional development. Many alternative variables are considered, but this variable seems to be the best single proxy for regional development. The data suggest that more–developed PHCs have a lower mortality level, but this was not associated with low growth faltering at the individual level. Furthermore when other factors were considered in the analyses, the regional indicator became less significant. This indicates that households in more developed areas are more likely to have better individual characteristics, such as education, income, and use of modern health services. All of these characteristics can be linked with a low mortality rate.

9.2 STUDY LIMITATIONS

Several limitations should be noted from this study.

- Although this thesis has focused on the potential impacts of UPGK, ORT, immunization, family planning, and female education, these factors represent only some of a number of ways in which child survival intervention programs may contribute to improvements in child health status.

- Even though the utilization of child survival interventions results in an improvement on the child health status, our results are consistent with the growing realization that, given the complex causal structure of childhood mortality and growth faltering in LDCs such as Indonesia, there are no effective interventions not affected by socioeconomic factors.

- All data are gathered from a cross-sectional survey, which may have basic problems for the interpretation of the findings. The most obvious problem would be the difficulties in establishing the "direction of causation".

- Survey data can suffer from many biases, including a "recall bias" and, less seriously, a "sampling bias". For example, exposure to child survival intervention was estimated based on the retrospective history, while a sample selection was performed using a multistage sampling, which involves blocking. None of our analyses were performed based on the complex survey design (*Fuller, 1986*), and statistically this may result in a biased estimate. Nonetheless, in practice a complex survey design is also analyzed by assuming a simple random sampling.

- Not all assumptions required for statistical analyses can be satisfied by our data. For example, the violation of the assumption of proportionality for variable UPGK underestimates UPGK's effect on the index of health status.

- Our study was conducted in a small region of Indonesia, which does not represent to the whole population of the country. It is not our intention to generalize this study for the whole Indonesian population. However, given that we have described in detail the characteristics of our study population, one may easily to find that the characteristics of this study area show some similarities with other areas beyond Java Island. In fact, there may be many areas in LDCs that have similar characteristics as our study population.

9.3 STUDY IMPLICATIONS

Two important implications can be drawn from this study that are relevant to LDCs in general. The issue concerns the evidence of a connection between child survival interventions and improvements in the child health status; the second issue relates to how the impact of child survival interventions should be evaluated in the population using a survey data.

We present empirical evidence that government health interventions can reduce mortality in areas considered to be poor and with limited health resources. However, health interventions are not the only critical factors that result in a substantial decline of mortality. An improvement of health sector such as provision of child survival interventions is only a part of many other general developments that contribute to mortality declines and improvements in nutritional status level. This implies that evaluation of the impact of health programs should take other developments into consideration.

There is little evidence from this study that can be used to oppose the popular notion that childhood mortality reduction in Indonesia has largely been a product of the primary health care interventions (*Hull and Gubhaju, 1986*). However, our results should be applied to other areas of LDCs with caution, since many factors that influence both mortality and nutritional status in Indonesia are different for other areas. One should be able to identify from the complex web of child survival interventions and socioeconomic factors those which could be isolated as important and map out the causal links between interventions, socioeconomic factors, and survival or nutritional status.

The striking differentials in child health status according to mother's education, father's occupation, and household income in Timor deserves special attention, since the differentials were observed consistently both for levels of mortality and nutritional status. Incorporating these characteristics would permit the influence of socioeconomic status to be controlled. Such selectivity is important in explaining the significantly high risk of mortality or poor growth for children. This is an important goal, namely the attempt to identify the most vulnerable groups of children, who appear to have been left behind, or are lagging in participation in the benefits from health and socioeconomic development. In this case, we need to increase our understanding of who is not being reached by existing developments as well as why they are not being reached.

A broader implication of this study is that it is relevant and feasible to assess alternative strategies for child survival interventions in terms of delivery and efficiency. Our study shows that a UPGK program can act as a catalyst of change in the utilization of other child survival interventions. The implication of the results is that integration of community based programs such as UPGK or POSYANDU would be a more efficient approach as opposed to a single–targeted intervention. For example, to cover about 75 percent of children who were left behind in immunization programs should require less resources, if the immunization program can be delivered through a UPGK program.

Because of the cost of intervention is the most salient issue in LDCs, the government should adopt a development strategy that enhances the ability of families to care for themselves, such as via UPGK. Monitoring the growth of all young children provides the opportunity for regular contact between mothers and community health workers and health providers. Therefore the UPGK program should improve mother's knowledge of child health care, either directly from health providers or indirectly through conversation with experienced mothers. Such educational aspects should focus on a wider range of goals that may result in a reduction in fatality in the face of a child's illness and better food preparation and allocation for children. However, an effective UPGK program requires essential activities other than weighing children and educational innovations. These activities should cover delivery of vaccines, distribution of vitamin A, or even contraceptive methods for mothers.

Despite the significant association between child survival interventions and child mortality, the distribution of health interventions still has two major problems. The first problem is low utilization of child survival interventions that mostly depend on the government health services, such as immunization, ORT, and family planning programs. In contrast with these intervention programs, the UPGK program does not necessary depend government health providers, and yet it has covered more than half of children under–5 years old. This indicates that the integration between UPGK and immunization, contraceptive, and ORT should be improved. Such integration requires a better community participation and a new approach that shifts the focus from existing methods of health care delivery which are usually defined and dominated by medical professionals. This means that community workers should become involved in both the delivery of and decisions about the type of health service most appropriate to their own circumstances. There is a need to develop new attitudes among health policy makers concerning the role of community participation in the delivery of child survival interventions and the expectation about what and how those roles should be carried out.

Our findings clearly suggest that socioeconomic backgrounds of the community and households still play significant roles in the utilization of child survival interventions. Therefore targeted interventions should also focus on the “vulnerable” group in terms of socioeconomic backgrounds. A wider approach of intervention should also be considered. For example, the intervention should come not only from health provider to mother, but must also include discussion from more educated to less educated mothers. All possible media of communications should be considered, including from child to mother through school–based health programs and from children–to–children.

The second issue is the inability to directly link child survival interventions and nutritional status at the individual level. Evidence suggest that only an indirect effect of family planning was shown to be an important determinant of nutritional status. Furthermore, family planning programs increase the number of short (*stunted*) children. But these short children may have normal weight according to their age, or normal weight according to their height. Are they in fact “small but healthy” children?, as suggested by Seckler (*1982*). We certainly do not assume they are. Nevertheless, under rapid mortality decline one should not view an increase in the number of stunted children in the population as an indicator of the failure of child survival interventions.

A reduced mortality risk is not always followed by an improvement in child growth in the population. In fact, at a certain transitional period where socioeconomic development hampers food supply, it may increase the prevalence of growth faltering. This finding may reopen an old debate on what level of malnutrition should be of concern for nutrition intervention programs (*Gopalan, 1983; Sukhatme, 1982*). Although redefinition of stunting could improve the estimated impact of child survival interventions, the long–term adverse effects of stunting in children in terms of mental, emotional, and physical well being are not well known. We have argued that redefinition is not necessary, since an impact assessment could use “a small but healthy” as a turning point indicator (*baseline achievement goal*) toward “a normal and healthy” population, which should normally be achieved when the socioeconomic level has been improved.

No one should doubt good nutritional status is an important goal for health programs. But what should be done about growth faltering still open to discussion (*Berg, 1987; Gopalan, 1983; Sukahatme, 1982*). We believed that food systems approach (*Berg, 1987*), which advocated integrated development programs that meshed primary health care, nutritional supplement (*mainly for vitamin and micronutrient deficiencies*), food production, and food marketing should be adopted by the country, in order to combat growth faltering. Thus child survival interventions that are delivered through primary health care should not be viewed as a single and an isolated government interventions rather as a part of general developmental programs. This stance is consistent with our premise that it is important to consider not only mortality but also nutritional status as outcomes on evaluating the impact of child survival interventions in a given population. The proposed a new index of health status, therefore, should be used for evaluating the impact of child survival interventions.

9.4 SUGGESTION FOR FUTURE RESEARCH

More studies are needed to establish the relationship of child survival interventions to health status using indicator that combine mortality and nutritional status to assess impact. Such studies can be done without a special effort for data collection since some countries frequently conduct a household survey, which includes the nutritional status and mortality data. However, they often fail to include appropriate questions that can be used for mortality analysis.

The Brass's type questions, which can be used for analysis of mortality trend, should be included in the nutritional and household health survey. The reason is that the use of some nutritional status indicators (*height–for–age*), may mislead policy makers if the mortality decline is not considered. Further studies are needed to reconfirm that health interventions focusing child survival technologies cannot determine child nutritional status.

The utilization of our a new index of health status should be repeated in the areas with difference mortality and nutritional status levels. We should also consider a similar study in the area that has higher the utilization of child survival interventions than our study area. Comparative studies between countries may be performed to establish consistency of our findings to more general population.

Our statistical models for ordinal data assume that the effects of all covariates are proportional. Further studies may be conducted by restricting proportionality assumption (*Petersen and Harrell, 1990*) if there is an indication that some variables violate the proportionality assumption.

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Table 9.1: Appendix 4.1: LIST OF PUSKESMAS, NUMBER OF VILLAGES AND NUMBER OF BLOCKS IN THE TARGET POPULATION AND SAMPLE

No.	Name of PUSKESMAS	Village Total	Village Sample	Blocks Total	Blocks Sample
01.	Bakunase	12	7	107	8
02.	Batakte	20	6	53	6
03.	Baumata	20	7	69	8
04.	Camplong	17	6	74	8
05.	Oesapa	24	8	79	9
06.	Kupang Kota	13	5	67	8
07.	Lelogama	14	5	31	6
08.	Naikliu	15	6	37	6
09.	Oekabiti	21	9	82	10
10.	Ayotupas	13	5	52	6
11.	Batuputih	14	7	76	8
12.	Bokong	9	4	31	5
13.	Fatumnasi	8	3	29	7
14.	Kapan	11	5	48	8
15.	Niki-Niki	25	9	116	9
16.	Oeekam	23	10	119	11
17.	Oekamusa	3	2	33	6
18.	Oinlasi	17	7	59	8
19.	Panite	27	10	118	11
20.	Pollen	5	3	21	7
21.	Siso	9	5	44	7
22.	Eban	19	7	52	8
23.	Lurasik	11	3	21	6
24.	Manufui	14	6	29	6
25.	Neomuti	10	3	20	6
26.	Nunpene	29	8	73	9
27.	Oelolok	17	4	45	7
28.	Ponu	5	3	11	5
29.	Wini	6	3	15	5
30.	Boas-Seon	8	5	48	5
31.	Betun	11	6	78	7
32.	Halilulik	8	5	82	8
33.	Namfalus	3	3	24	5
34.	Wedomo	12	3	56	6
35.	Weluli	12	6	41	7
36.	Weoe	20	10	137	12
	TOTAL	505	204	2077	264

Appendix 4.2: ESTIMATION OF SAMPLE SIZES

The objective of our analysis is to estimate the differences between some rates or proportions (i.e., IMR, Stunting or wasting) in two domains. For example the differences of IMR between groups used high and low health inputs is our main interest here.

Let define as follows:

1. The primary sampling unit (PSU) is the unit of selection in the first stage of selection in a multi-stage sample. In this study, a cluster or block will be considered as the PSU.
2. Cross-Class Domain. The name given to a sub-group of population (i.e.,a group of immunized children) in which one would expect to find members in all PSUs.
3. Segregated Domain. The name given to a sub-group of population (i.e.,a children lived in urban or rural areas) in which each PSU consists of either members or all non-members of the sub-group.
4. Enumeration unit. The unit in the survey population being observed to produce the survey estimate For example the enumeration unit for IMR is births during the reference year to women 15-49 years. The enumeration unit for proportion death among children ever born (PDCEB) is children ever born to women 15-49 years).
5. n is a symbol which denotes the total number of enumeration units in the sample to produce a particular estimate.
6. n_{hh} is a symbol which denotes the total number of households in a particular survey sample. It should be noted that n and n_{hh} are not the same. For example, when estimating an IMR we will have $n = k(CBR)(n_{hh})$, where k is average number of children per household (i.e.,5) and CBR is a crude birth rate. Similarly when we estimating PDCEB we can assume that the average number of woman at age 15-49 years per household is one, so that $k = 1$ or $n = CEB(n_{hh})$.
7. π This is a symbol for the proportion of enumeration units which fall in a domain for which an estimate is being produced. Thus, the number of enumeration units that are members of the domain will be $\pi \times (n)$.
   π_1 is the proportion of enumeration units in the first domain, and π_2 is the proportion of enumeration units in the second domain.
8. b denotes the average number of enumeration units per sample PSU. For example, in estimating IMR this would be the per-PSU average number of births during the reference year to women age $15 - 49$ years in the sample.

9. b_{hh} denotes the average number of household per sample-PSU. Thus, the relationships between b and b_{hh} for IMR estimation is: $b = k(CBR)(b_{hh})$.
   Here k is an average number of children per household and CBR is a crude birth rate.

10. P is a symbols which denotes the population measure being estimate (i.e., IMR or PDCEB). This number is unknown, but we must estimate base on the existing information.
    P_1 is the population measure being estimate in the first domain, and
    P_2 is the population measure being estimate in the second domain.

11. D or $= P_1 - P_2$ is the differences of population measure between two domains.

12. ρ symbol is used to denotes the intra-class correlation which quantifies the degree to which enumeration units within PSUs are similar with respect to the population measure being estimated.

13. $DEFF$ is design effect that is the variance of an estimate produced from a cluster sampling design divided by the variance of the same estimate produced from a simple random sample of the same size. Thus this measures the effects of cluster sampling relative to a simple random sampling of elements (*Kish et al 1976*).

    Formula for a design effect on the total population estimate is:

    $$DEFFT = 1 + \rho(b - 1) \tag{9.1}$$

    Formula for a design effect on the Cross-Class Domain estimate is:

    $$DEEFcc = 1 + 1.2\rho(\pi \times b - 1). \tag{9.2}$$

    Formula for a design effect on the Segregated Domain estimate is:

    $$DEFFs = 1 + 1.2\rho(b - 1). \tag{9.3}$$

14. CV is the coefficient variation of the estimate differences between two population measures. Kish et al (*1976*) suggested that we should use two extreme values of CV: upper and lower values.
    CV_l is a coefficient variation for the lower value, and
    CV_u is a coefficient variation for the upper value.

    When $\pi_1 = \pi_2 = \pi$ or we have segregated domain, the relationship below is hold.

    $$CV_u = (DEFF)^{1/2} CV_l, \tag{9.4}$$

    where the value of DEFF depends on whether we have two cross-classified or segregated domains. Since CV should have two values (upper and lower bounds), the sample size estimated would have two numbers.

The sample size (n_{hh}) for pre-specified CV is determine by solving n in equation below and obtaining nhh form the relationship between n and n_{hh}.

The lower bound of CV is resulting:

$$n = \frac{(P_1(1-P_2))/\pi_1 + ((P_1-D)(1-P_1+D)/\pi_2)}{CV_l^2 D^2} \tag{9.5}$$

and when $\pi_1 = \pi_2 = \pi$, or we have segregated domains, the upper bound CV is giving

$$n = \frac{(P_1(1-P_2))/\pi_1 + ((P_1-D)(1-P_1+D)/\pi_2)}{CV_u^2 D^2} \tag{9.6}$$

The number of households, n_{hh}, is $= n/k.CBR$ for IMR differences or $= n/k.CEB$ for the difference of PDCEB.

Because the IMR is likely to be the lowest "proportion" out many possible outcomes (i.e. compare to the proportion of wasting children); we considered this outcomes becomes base of our sample size estimation. We wish to know how many households are needed for a survey in which the estimated "low" and "high" health inputs differences of IMRs is sought.

At the time of survey we assumed that:

1. we wish for the lowest Coefficient Variation (CV) of our estimated differences to be 0.20,
2. crude birth rate (CBR) in the population is 35 per 1000,
3. 85% of birth occur to a women with a low health input (π_1),
4. 15% of birth occur to a women with a high health input (π_2),
5. the IMR for a low health input domain of this province is around 120 (P_1),
6. the IMR for a high health input domain of this province is around 70 (P_1), so the expected differences (D) is about 50 per 1000 births,
7. the proposed sampling design will cover about 25 households per PSU,
8. the average number of persons per household is 5, and
9. intraclass correlation for proposed sampling design in this study is about 0.005.

Using these assumptions, the n_{hh} for upper and lower bounds estimated are 11,515 and 10,065 respectively. The finite population correction has not been considered in this estimation. If, however, the sample size estimated is large relative to the number of households in the population (N_{hh}), the required households sample size should take into account the effect of sampling from a finite population. Kalsbeek (1982) suggests this formula:

The total sample size $= \frac{n_{hh}}{(1+n_{hh}/N_{hh})}$.

Thus the ultimate sample size will be smaller when n_{hh}/N_{hh} is a relatively high.

Appendix 4.3: DESCRIPTIONS OF STUDY FORMS

- **TYPE A: Family and Household Structure and Characteristics.** This part of the form was printed in a yellow color, and it is divided into five sections:

    1. Section A.I: The first section of this form covers information on respondent's geographic location (*district, sub–district, urban–rural*) and sample identification.
    2. Section A.II: This section was filled in after an interview is completed since it covers: a) the total number of member in the household, b) the number of women ever married and below 55 years of age, c) the number of children aged under 5 years, d) the number of deaths of children born within the last 5 years, e) the number of growth and immunization cards copied from this household, and f) the number of children aged under 5 years who had their weight, height, and the BCG scar examined.
    3. Section A.III: This section records the number of field visit to a particular household and the date of the final household visit. It would be used as a basis of age calculation using dates of birth.
    4. Section A.IV: All members of the household were listed in this section. The head of the family was asked about age, gender, marital status, occupational status, and level of education of all household members.
    5. Section A.V: Four conceptual variables were intended to measure the socioeconomic status of the household: 1) land–holding status, 2) household cash expenditures, 3) number of modern amenities within the household (*i.e., television, radio, car, etc.*), and 4) animal livestock belonging to the family. Environmental condition was measured based on the basis of "a crowding index", wall and roof materials, water sources for drinking, cooking and bathing, and the availability of a sanitary facility. In addition to these data, this section covers information on the availability of modern and traditional drugs at the time of survey, availability of soap, and the total cash expenditures for treatment of the members of the household per month (averaged based on information on the last of 3 months expenditures).

- **TYPE B: Married Women Aged Under 55 years.** This part of the household form was printed in a white color. This form is divided into six sections. Respondents for this form were all ever married women under 55 years of age.

    1. Section B.I: This section covered information on women's age, duration of stay within a sub–district, level of education, distance between home and the work–place, and religion. Similar information was asked for her husband.

2. Section B.II: Every respondent was asked about their status and activity in these community organizations: 1) Women Club (*PKK*) 2) Health Cadre (*Kader sehat*) 3) Nutrition Cadre (*Kader gizi*), 4) KUD, 5) Arisan 6) Kelompok Tani and 7) any other organization. All of these organizations usually have monthly meetings, so judging by attendance the last at three meetings, we classified a woman as an active or nonactive participant in her organization.
3. Section B.III: This section was devoted to women's knowledge on DPT, BCG, measles, polio, TT immunizations, and the practice tour antenatal care (ANC) and Family planning. Details on each immunization were asked in regard to the place of getting vaccination, the use of this vaccine, the knowledge about when and how many times each vaccine should be given. The place of ANC and the source for contraceptives used were also asked in this section.
4. Section B.IV: This section is a standard of Brass's question type which has been used in many surveys in Indonesia. Information included are: 1) age at first marriage, 2) age first delivery, 3) number of children ever born, 4) number of children currently living within household, 5) number of children currently livening outside household, and 6) total number of non–surviving children. All child information was classified according to sex.
5. Section B.V: A set of questions was put to the mother regarding the status of her last live birth and the previous birth. The importance of this approach is unique confirmation about the date of birth according a certain calender event and the question whether delivery was a stillbirth or a live birth. Similar questions were asked in three previous national surveys (*CBS, 1987*).
6. Section B.VI: After a woman was asked about her fertility status, the conversation was devoted to reconfirmation again about the children ever born within the last five 5 years. In this case, each woman was asked to find a birth certificate, a baptism card, growth and immunization cards, or other records which may have date of birth information for her child. The husband or another relative may have helped to find such information. Children ever born then was reconfirmed using a similar question as in section V, but it would not stop at asking the next previous birth unless the last of child asked was not born 5 years or more before the survey date. In other words, we stopped at the last child born 5 year or more before the survey date. This list covered all children ever born who still survived and who had already died. Using this list, if there were one surviving and one non–surviving child born to the same mother, the interviewer would use one form type C and one form type D.

- **TYPE C: Surviving Children Under Ages of 5 Years.** This part of the questionnaire collected data on surviving children under 5 years old, and is divided into four sections:

1. Section C.I: This section covers information on age, sex, and nutritional status of the child. Details on information about place and time of vaccination were asked, including when and if the vaccination was given. Mothers was asked whether their child had ever been brought to the Center Weighing Program. If so, a follow–up question was asked on if she knew her child's weight status at the last visit (*good, moderate, or bad*).
2. Section C.II: This section covers information on the ANC, a birth place, birth attendant, breast feeding practice, food supplement, and previous contraceptives used before pregnancy with this child.
3. Section C.III: This section covers information about child's morbidity status within the last 2 weeks, and general symptoms and curative treatments given, including place of services obtained.
4. Section C.IV: This section records weight, height, and result of BCG scar examination. Regardless of answers to these questions, the age, sex, and child identification were also recorded by interviewer during household visit.

- **TYPE D: Non–Surviving Children.** This part of questionnaire was used to collect data on non–surviving children born within the last five years. Most of the questions that applied to surviving children were also asked in this part. There are no details on information regarding cause of death in this survey except the symptoms found before death.

- **TYPE E: Growth Monitoring and Immunization Cards.** This part covers information extracted from the growth and immunization cards. Only children who had ever been weighed or immunized had this information. We copied data on the last of three measurements from the growth card, as well as kinds and time of immunization given, and dates of birth recorded on these two cards.

CURRICULUM VITAE

ADDRESS

N a m e :	SISWANTO AGUS WILOPO
Home Address :	Resonegaran GK I/267 A, Yogyakarta, Indonesia
Office Address :	Clinical Epidemiology and Biostatistics Unit, Faculty of Medicine/Dr. Sardjito, General Hospital, Yogyakarta, Indonesia, (0274)-87333 Ext. 814 (0274)-88688 Ext. 432, 552, 554.
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PERSONAL DATA

Date of Birth :	03-15-1953
Place of Birth :	Boyolali, Central Java, Indonesia
Citizenship :	Indonesian

EDUCATIONAL BACKGROUND:

B.Sc. (1974)	(Medical Sciences). Gadjah Mada University, Yogyakarta, Indonesia.
Drs. Med. (1977)	(Medical Sciences). Gadjah Mada University, Yogyakarta, Indonesia.
M.D. (1979)	(General Practitioner). Gadjah Mada University, Yogyakarta, Indonesia.
M.Sc. (1983)	(Basic Medical Sciences). Faculty of Graduate Studies, Gadjah Mada University, Yogyakarta
M.Sc. (1985)	(Design, Measurement, and Evaluation in Health Care and Research . The Department of Clinical Epidemiology and Biostatistics, McMaster University,Hamilton, Ont.,Canada.
Doctorate Candidate (1986-)	(Public- Health). The Johns Hopkins University, Baltimore, Expected to complete on June 1989. MD, USA

CURRENT AREA OF INTEREST:

Multi-Level Modelling on Research of Regional Variation of Child Survival in Indonesia.

Biostatistical Problems on the Design, Measurement, and Evaluation in Health Care and Research.

Data handling and Problems for Hierarchial File in Data Base Management on Medical Records.

Computer Programming on Linear Models or Non-normal Regression.

Teaching on the Computer Statistical Package programs: SAS, BMDP, SPSS etc.

CURRENT STATUS AT GADJAH MADA UNIVERSITY:

Staff member of	The Clinical Epidemiology and Biostatistics Unit, Gadjah Mada University/Dr. Sardjito General Hospital, Yogyakarta, Indonesia (on leave).
Research Staff from	The Population Studies Center, Gadjah Mada University, Yogyakarta (on leave).

EMPLOYMENT HISTORY:

1975-1977 :	Part-time Assistant, Department of Physiology, Gadjah Mada University Yogyakarta, Indonesia.

1979-1985 :	Lecturer of Faculty of Medicine, Gadjah Mada University assigned at: – Department of Physiology,and – Program Community Comprehensive Health, Care Education Programmes.
1985– :	Lecturer of Faculty of Medicine, Gadjah Mada University assigned at: – The Clinical Epidemiology and Biostatistics Unit,and – Population Studies Center,

FELLOWSHIPS:

Fellowship grants from The Ministry of Education Republic of Indonesia for the Master Program in Basic Medical Sciences in the Faculty of Graduate Studies, Gadjah Mada University, Yogyakarta. 1981-1983.

Fellowship grants from The Rockefeller Foundation through McMaster University for the Master Program in Design Measurement and Evaluation on Health care and Research, in The Department of Clinical Epidemiology and Biostatistics, McMaster University, Hamilton, Ontario, Canada. 1983-1985.

Fellowship grants from The Ministry of Education Republic of Indonesia for the Doctoral Degree in Public Health in The Johns Hopkins University, Baltimore, MD, USA. 1986-1988.

COURSE TAUGHT:

Biostatistical Methods , Data Management, and Data Analysis.

Medical Demography .

RESEARCH EXPERIENCES:

1. Study of Determinants of Age Menarche in Yogyakarta. Sponsored by The Gadjah Mada University and Rockefeller Foundation, New York, 1981-1982 (Co-Investigator).

2. Project Computer Development for Data Analysis in Health Research. Sponsored by the Rockefeller Foundation, New York, 1981-1983 (Principle Investigator).

3. Study Acute Effects of smoking on the electrocardiographic pattern and blood pressure. Sponsored by Ministry of Education and Culture under the Grant No. DP3M No. 47/DPM/1981: 1981- 1982 (Principle Investigator).

4. Study Acute Effects of smoking on the Pulmonary Function test patterns in smokers and non-smokers. Sponsored by Ministry of Education and Culture under the Grant No. DP3M No. 410/DPM/1982: 1982-1983 (Principle Investigator).

5. Problem Oriented Medical Records: a study formulation of Medical records for Research and Teaching in the Medical School Hospital. Sponsored by the Gadjah Mada University and Project of The Five Years National Development Plan (PELITA): 1982-1983 (Co-Investigator).

6. Study Endocrine Adaption to Exercise in Healthy Man: Thyroid Responses. Sponsored by The Ministry of Education and Culture and The National Atomic Energy: 1983 (Principle Investigator).

7. Study The relationships between Nutritional Status and Menarche in School Children in the urban areas of Yogyakarta.

8. Study prognostic factors for Hospital Maternal Mortality in Yogyakarta. Sponsored by The Ministry of Education and Culture: 1983 (Co-Investigator).

9. Study Effect of Mother's habits on Smoking and Chewing Tobacco to Child Survival status in West Java: Secondary Data Analysis from Cohort Study in Sukabumi. 1986-1987. Sponsored by the Rockefeller Foundation and The LITBANGKES (Co-Investigator).

10. Study on the Regional Variation of Child Survival in Indonesia: with a special attention on the issues of multi-level variables.

PUBLICATIONS:

1. Wilopo, S.A., Hari Kusnanto, J.H., and Rohde, J.E. (1980). Comparison of Nutritional Results of Clinics Based and Village Based Weighing Programmes. Pediatrica Indonesiana 20: 93-103.

2. Wilopo, S.A. (1982). Differential of Fertility of Woman in Central Java: Cross-Classified Tables Analysis. In: The Differential of Fertility in Indonesia, Edited by H. Hatmadji; B. Soeradji, and S.I. Achmad. Demographic Institute of Indonesia, Jakarta. pp: 352-427 (in Indonesian).

3. Wilopo, S.A. (1982). Differential of Fertility of Women in Central Java: Multiple Classification Analysis, in: Differential of Fertility in Indonesia, Edited by H. Hatmadji; B. Soeradji, and S.I. Achmad. Demographic Institute of Indonesia, Jakarta, pp.: 429-478 (in Indonesian).

4. Wilopo, S.A., Hakimi, M.H., and Sanusi, R. (1983). Techniques Stations: A method of Practical skill assessment for medical student. Faculty of Medicine Gadjah Mada University, Yogyakarta, pp: 225 (in Indonesian).

5. Wilopo, S.A. (1983). Changes of Thyroid Hormones Concentration After Exercise as Measured by RIA and their correlations with Physical Fitness. un-Published Master Thesis in Basic Medical Sciences, Gadjah Mada University.

6. Rochmah, W., Wilopo, S.A., and Aswin, S. (1984). The relationships between blood pressure and anthropometric sizes of the Junior High School Students in the Municipality of Yogyakarta. Berkala Ilmu Kedokteran, 16: 95-99 (in Indonesian).

7. Wilopo, S.A., (1985). Biostatistical Methods in The Design, Measurement, and Evaluation in Studies of Human Fertility Regulation. Published Master Thesis in Design, Measurement, and Evaluation in Health Care and Research, Department of Clinical Epidemiology and Biostatistics, McMaster University.

8. Wilopo, S.A.; Hakimi, M; Anwar, M. (1985). Some aspects of data management and analysis in the Study of secure contraception. Mantap: 4, 35-46. (in Indonesian)

9. Wilopo, S.A., and Hakimi, M. (1985). Method on Measurement of the Impact of Morbidity and Mortality on the Health Status of Population. Seri Epidemiologi Klinik dan Biostatistik No. 1. (in Indonesian).

10. Wilopo, S.A. (1985). Study Design and Biostatistical Methods. From theories to the Decision Tree of Questions and Answers Leading to Appropriate Statistics or Statistical Techniques. Seri Epidemiology Klinik dan Biostatistika, No.2. pp. 147.

11. Wilopo, S.A. (1985). Twenty five of Statistical Questions during Biostatistical Consultation. Seri Epidemiologi Klinik dan Biostatistika No. 3 (in Indonesian).

12. Wilopo, S.A.; Hakimi, M.; and Anwar, M. (1987). Prediction of Ovulation using BBT by CUSUM Statistics. Medika-Edisi Khusus untuk Reproduksi Manusia, pp: 77-83 .